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STREET RAILWAY PROFITS in Washington, D. C., enter into the dicussion of a bill now pending which proposes a local rate of 8 tickets for 25 cts. The bill is in the hands of the Senate District Committee, and in speaking of it lately to a *Star* reporter Senator INGALLS mentioned the case of the Washington & Georgetown Co. The par value of this stock is $50, with $30 paid in. The latest quotation is $225 for this same stock. The receipts of the Seventh St. cable road sometimes run as high as $3,000 per day. Senator INGALLS advocates the Glasgow plan for future street lines. In Glasgow the companies pay a heavy rental for the use of the streets, and another certain percentage of income to the city. They must also put another percentage into a sinking fund, and when this fund is large enough to recoup the company, the road becomes the property of the city and is operated by it.

WORKMEN'S CHEAP TRAINS are made the subject of a bill now before the English Parliament. This bill would require railway companies entering London to provide proper and sufficient trains for workmen to run between 6 A. M. and 8 P. M., and to charge such fares as may be fixed by the Board of Trade. Return tickets are to be sold at a rate not exceeding 1 cent per mile or part of a mile, and to cover a radius of 12 miles from the terminus. The Great Eastern Co. now carries passengers nearly 22 miles for 4 cts., and the third class season ticket on the Midland Ry. costs about 12 cts. per day for a 24-mile trip.

THE BOER REPUBLIC, in South Africa, has completed its first railway from Kimberley to Bloemfontein, the capital of the Orange Free States. This road is to be extended to Pretoria; and when the road, now under contract from Pretoria to the Eastern frontier, is completed there will be direct railway communication between Capetown and Delagoa Bay, a distance of 1,300 miles.

THE TWO MOST SERIOUS RAILWAY ACCIDENTS of the week were derailments, one near a bridge and the other near a trestle; both accidents occurred Dec. 18. On the Intercolonial Ry., an express train was wrecked near St. Joseph, Que. The train was made up of a baggage and mail car, one second-class car, one first-class car, and one sleeper. It was running at a high rate of speed, and after passing St. Joseph station the second-class car jumped the track at the end of the station siding, on a curve, and dragged the first-class and sleeper with it; the mail car and baggage car ahead of it were also derailed. The three passenger cars ran diagonally along the embankment for 200 yds., the second-class car striking the western abutment of the bridge, which carries the track over the public highway at this point; and the front of the car was smashed against the stone abutments. The three cars turned over, the first-class car being badly shattered. Fortunately, the curve on which they were running threw the cars away from each other, and though the heavy sleeper was carried half its length along the first-class car, it ran alongside of it instead of crushing through it, as it would have done on a straight line. The sleeper was not so badly smashed as the other cars. The engine, still drawing the baggage and mail cars, passed over the bridge, the timbers of which were badly broken up by the two cars derailed by the plunge of those cars in the rear. After passing the bridge the mail car went down the embankment, having apparently turned completely over in its descent. The engine and the derailed baggage car continued on, passing over a second road bridge safely, and were brought to a standstill a few hundred yards further on. Five persons were killed and 7 injured.

THE SECOND DERAILMENT ACCIDENT was on the Wheeling & Lake Erie Ry. near Bolivar, O., near a trestle over the Tuscarawas River. The train, composed of two coaches and a baggage car, was approaching Bolivar, when about a mile north of the town the front truck of the last car left the track just as the engine started across a long trestle 35 ft. high. Almost before the fact that anything was wrong could be known, the locomotive was running across the trestle, the rear car bounding along the ties. When fairly on the bridge it swung around and toppled over, falling to the ground bottom upward; the car at once took fire. The coupling connecting the car with the remainder of the train was broken and the air brakes automatically applied. Four persons were killed and 7 injured. Another account states that the derailment occurred on the trestle owing to the spreading of the rails on decayed ties. Another accident of this kind occurred, Dec. 23, at Watsonville, Pa., on the Western New York & Pennsylvania R.R. The rails spread under a passenger train, and 2 passenger cars and a baggage car went over an 8 ft. trestle. About 20 persons were more or less injured.

A CROSSING COLLISION occurred Dec. 17 at the intersection of the Southern Pacific and Portland & Vancouver railways at East Portland, Ore. Both trains had 6 or 7 cars filled with passengers. The Portland & Vancouver narrow-gauge train reached the crossing first, and after the engine and 2 coaches had gone over, the engine on the Southern Pacific plunged into the train, cutting it in two. Fortunately the engine struck the coupling between the passenger coaches, so that neither was badly damaged. They were turned over on their sides. No one was seriously injured.

TWO CAR HEATER ACCIDENTS are reported: the Baker heater in a car of the Chicago & Grand Trunk Railway, exploded Dec. 20, while the train was near Nicholas, Mich. The car was filled with gas, and the burning coal set fire to the car, but the flames were soon extinguished. On Dec. 17 a car of a train on the Annapolis, Baltimore & Washington R. R. was set on fire by the stove; the train was stopped and the trainmen extinguished the fire.

ANOTHER TRACK JACK ACCIDENT occurred on the Union Pacific Railroad, Dec. 21. The jack was lying on the track on a curve and caused the derailment of an engine and mail car, causing one fatal and one serious injury. It is suggested that the track was thus obstructed maliciously.

A LOCOMOTIVE STEAMBOAT is being built at Kristanstad, Sweden, for the navigation of a chain of small lakes near that place separated by falls. The track between the lakes is 3 ft. 6 in. gauge, with grades of 1 in 35, and curves of a radius of 100 m. The dimensions of the boat are not given in the *Nordstjernan*, from which we get this item, but the boat is said to be fitted with wheels beneath, fitting the track, and the transfer from lake to land is made by inclines. The motor operates either the propeller or the driving wheels of the "locomotive steamboat" as required.

BIDS FOR THE AMMEN RAM AND TORPEDO BOATS were opened by the Navy Department on Dec. 20. There was but one bidder for the ram of 2,050 tons, the Bath Iron Works, of Bath, Me. The price was $930,000 and this company declined to take back the vessel if it failed to make 17 knots, as per one of the conditions of the letting. For torpedo boat No. 2. the Herreschoff Co. put in two bids, one for $125,000 for a vessel of more than 125 tons, and one of $93,000 for a smaller vessel. The Cowles Engineering Co., of South Brooklyn, N. Y., bid $119,940 for the smaller boat.

DR. JUSTIN'S DYNAMITE SHELL was successfully fired, this time, on Dec. 20, at Rome, N. Y. A 275-lb. shell was charged with 7½ lbs. of dynamite. The shell was 38 ins. long and 9 ins. in diameter, made of forged crucible steel and free from the blow-holes that are charged with causing the previous disasters. The base of this shell was 3 ins. thick, and the point of solid steel. Within it was an inner wooden shell, 8 ins. long and 7¼ ins. diameter, containing the dynamite. Three of these shells were successfully fired, the shells exploding on contact with the cliff. The gun used was an old-fashioned 9-in. Blakeley rifle.

THE NEWPORT-CINCINNATI BRIDGE, now under construction over the Ohio River, will be opened to travel in March, 1891, says the Cincinnati *Commercial Gazette*. The bridge is being built by the Central Railway & Bridge Co., chartered in 1884, Capt. JOHN A. WILLIAMSON, President. The builders are the King Iron Bridge & Manufacturing Co., of Cleveland, O., Mr. G. W. FERRIS, Chief Engineer. Work was commenced in May, 1890. The superstructure will be steel, and in all 2,440 ft. long, with a channel span of 520 ft. of the cantilever type. The towers on the mid-river piers will be 185 ft. high above low-water mark. The masonry aggregates 378,000 cu. ft. in volume, and the pneumatic caisson was used in some cases to overcome the difficulty in foundations. The bridge will be 24 ft. wide on the roadway, affording room for two lines of street cars and a carriageway between.

THE NEW ORLEANS BRIDGE, says the *Times Democrat*, will not be chartered at this session of Congress. The Terminal Company has secured a favorable report from the commerce committee of the House and their bill is on the calendar. But there is a strong minority report against it, including the chairman of the committee among its signers. The other bridge bills are still in committee.

THE 443-FT. DRAW SPAN, of the La Crosse, Wis., highway bridge was finished and swung on Dec. 17. This draw span is the longest on the Mississippi River. The bridge itself includes, besides the draw span, one 300 ft. and two 130-ft. spans, and 129 ft. of iron trestle approach. It was erected by the Clinton Bridge Co. for the city of La Crosse at a cost of $83,000.

THE MIDDLETOWN-NEW UTRECHT TUNNEL BILL was passed by the House at Washington on Dec. 20. This bill proposes a tunnel under the Narrows at New York, and its construction would be of importance to Brooklyn commerce, connecting that city by rail with the West and other sections of the country.

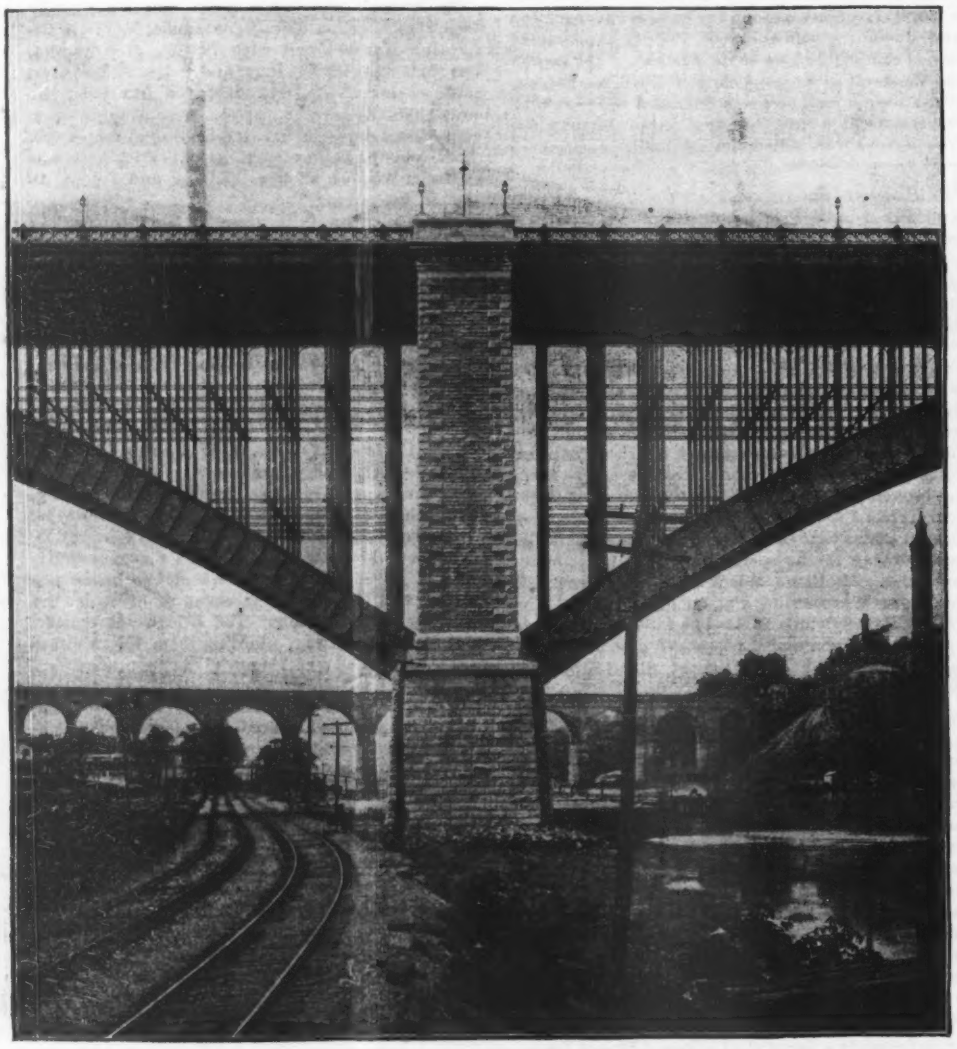
THE NICARAGUA CANAL WORKS, according to various reports made public this week, are advancing very favorably. The depth of water on the bar at Greytown has been increased from nothing to 12 ft., and it is expected to deepen it to 20 ft. within a month, which will afford ample harbor facilities for construction purposes. The other contents of the report have been in their substance already given in these columns.

THE PUBLIC WORKS DEPARTMENT OF NEW YORK has had appropriated to it for 1891 the sum of $3,053,720. This is $162,495 less than for the year preceding.

Designs Submitted for the Washington Bridge over the Harlem, New York City.

(WITH INSET.)

In our inset this week we show fourteen plans submitted for the Harlem River crossing of 181st St., New York City, for the site now occupied by the Washington Bridge. These plans are interesting as showing what may be called the evolution of a bridge, and they cover the best of the designs submitted, from those of Mr. WM. J. MCALPINE, then Chief Engineer of the Department of Public Parks, in 1878, to the finished structure built under Mr. WM. R. HUTTON, Chief Engineer. We are indebted for the originals and the description following to the forthcoming "History of the Washington Bridge," by WILLIAM R. HUTTON, Chief Engineer, noticed in our issue of Dec. 13, 1890. These designs



VIEW OF CENTRAL PIER OF WASHINGTON BRIDGE, OVER HARLEM RIVER, NEW YORK CITY.

are a fair example of the completeness and character of the illustrated portion of the history referred to.

Before generally describing the various plans, it may be well to state, for the information of those not familiar with the locality, that the conditions practically required a single span over the Harlem River, and such an arrangement of piers as not to interfere with the New York Central & Hudson River and the New York City & Northern railways, already occupying the east bank of the river. Certain avenues, higher up on the eastern bank and parallel to the river, had also to be considered.

The demands for some better means of communication between the high ground on the two sides of the Harlem river at this point may be said to have assumed an imperative shape in 1868; and about that date Mr. ANDREW H. GREEN, the executive officer of the Board of Commissioners of Central Park, suggested a suspension bridge. In accordance with this suggestion the Legislature, in 1869, passed an act authorizing a survey of part of Westchester County and the location of bridges or tunnels over or under the Harlem River. By an act of May 19, 1870, ample authority was conferred upon the Park Department to bridge the Harlem River, and on Feb. 23, 1876, commissioners were appointed and land condemned for the approaches.

In 1878 Mr. WM. J. MCALPINE, Chief Engineer of the Department of Public Parks, reported four alternative designs for a bridge at this site (see Figs. 1, 4). The estimated cost of each was as follows, the spans being given on the elevation, with a roadway, in each case, 32 ft. wide and two sidewalks of 7 ft. each, No. 1, $1,500,000; No. 2, $2,100,000; No. 3, $800,000; No. 4, $4,000,000.

In 1883, the Park Commissioners engaged Mr. A. P. BOLLER, Messrs. BUCK & MCNULTY and WILSON BROS., to study and report plans, and the results are shown in Figs. 5, 6, 7. Mr. BOLLER proposed a cantilever bridge (Fig. 5) 100 ft. wide, estimated to cost $1,000,000. Messrs. WILSON submitted two plans, a cantilever on masonry piers, to cost $1,193,247; and a cantilever (Fig. 6) on iron piers and masonry foundations, to cost $1,032,954. Messrs. BUCK & MCNULTY submitted a plan for a metal arch of 400 ft. span, with masonry approaches, 50 ft. wide. The estimated cost was $3,064,624; and it is said that this plan met the approbation of the Commissioners, but its cost deterred them from accepting. It was a very handsome design.

After some further delay, three commissioners were appointed in 1885 to build a bridge. This commission was made up of Messrs. VERNON H. BROWN, JACOB LORILLARD and DAVID JAMES KING, with Mr. M. W. NIVEN as Secretary, and Mr. WM. J. MCALPINE as Chief Engineer. In October, 1885, competitive plans, specifications and estimates for a bridge were asked for, and 17 in all were received. Of these illustrated, No. 7 shows a plan submitted by the Union Bridge Co., of New York, for a bridge of three arches of 280 ft. span each, constructed of *beton Coignet* and faced with granite. But as this bridge was neither "stone, steel nor iron," it was concluded that it did not come within the materials authorized in the act. For a somewhat similar reason, as the competition required the main spans to be of metal, the handsome plan of Mr. JULIUS W. ADAMS, made by the special request of Mr. MCALPINE (Fig. 10), was also not acceptable, though it was considered to have the greatest merit of the plans submitted in the last competition.

A board of experts had been appointed to examine and report upon the plans submitted. This board was made up of Mr. P. P. DICKINSON and Mr. THEODORE COOPER, civil engineers, and Mr. EDWARD H. KENDALL, architect, acting with Mr. MCALPINE as Chief Engineer. The experts awarded the first prize to Mr. C. C. SCHNEIDER (Fig. 11), and the second premium to Mr. W. HILDENBRAND (Fig. 12). The Union Bridge Co. also presented a modification of the *beton* arches by substituting for them steel ribs with solid webs. This plan was not acceptable to the Commission, and they again submitted general plans, differing from those of Messrs. SCHNEIDER and HILDENBRAND, in the use of a plate web instead of bracing between the flanges of the arch in these designs.

After some modification by Mr. ALPINE and Mr. COOPER, the latter now made Consulting Engineer, the design shown in Fig. 13 was finally adopted and tenders were invited on April 22, 1886. Ten proposals were received for earthwork and masonry, ranging from $1,093,000 to $1,697,700; and five proposals for metal work, ranging from $687,500 to $1,180,000. As it was desirable that the work should be let in one contract, new bids were called for, and on July 14, 1886, the contract was executed with the Passaic Rolling Mill Co. and Mr. MYLES TIERNEY for the entire work for the sum of $2,055,000, of which $845,000 was for the metal work. Mr. WM. R. HUTTON was now made Chief Engineer, and work was commenced in July, 1886. Fig. 14 shows the structure as finally completed. The iron work is practically the same as in Fig. 13, the changes made being chiefly in the decorative parts. But Mr. HUTTON very much improved the design of the masonry approaches, and carried out all the details of the structure with a thoroughness and good taste that is alike creditable to him, as Chief Engineer, and to the City of New York which built the bridge. The simple grace and dignity of the old High Bridge, in the immediate vicinity, would have made still more striking any lack in either feature in the modern design. The final cost of the structure was slightly in excess of $2,850,000.

Sewerage of West Bay City, Mich.

During the year 1888-9 a system of sewers was designed and constructed by the Board of Public Works, under the directions of JOSEPH N. DREW, who made the preliminary plans and was retained as consulting engineer, the work being in charge of H. C. THOMPSON, to whom we are indebted for these data. The accompanying illustrations show the principal details of construction, and need no comment further than is given below.

The outlet is into the Saginaw River, and lying back from the river is a low, marshy tract of ground running parallel to and about 2,000 ft. from it. Between this bayou and the river is a sand ridge upon which the business part of the town stands.

The principal object sought was to drain the bayou, and in connection therewith to establish a system that would meet the requirements of drainage for all time to come.

The city was divided into main sewer districts for the purposes of taxation; each district to be supplied with a district sewer into which all lateral sewers lead; these district sewers in turn being connected with the main sewer.

The main sewer is constructed of double rings of brick, and all district and lateral sewers of socket tile. The outlet is a box 5 × 5 ft. inside, made of 6 × 6-in. Norway pine, drift-bolted together, with a 4-in. top and bottom spiked to the sides. The box is 175 ft. long, and at the lower end the bottom is 18 ins. under ordinary water level. When solid ground was found the brick work was started and excavations made. It was necessary to keep the pumps constantly in use, as the bottom was below the surface of the river and the soil sharp sand. A wood invert was provided to shape the sides and bottom

of the trench, and the brick laid thereon for a distance of about 600 ft., when clay was found of sufficient hardness to be shaped by lines and templets to receive the brick.

The sewer from the river to the bayou is 5 ft. inside, round, a distance of 3,000 ft., on a grade of 16 ft. in 2,000.

In this distance there are two curves of 80 ft. radius, and there is practically no change in the velocity of the current around them. At the bayou the bottom was not solid enough to build on, and piles were driven 24 ft., sawed off, and timbers laid thereon for a foundation. After intersecting the bayou, the sewer was changed from round to egg-shape, 36 × 54 ins., and this size continued on a grade of 1 ft. in 1,000 a distance of 2,900 ft., where, after making another angle and crossing the bayou a second time, the size was again reduced to 28 × 42 ins., which size was continued 2,500 ft. The average depth of the large size sewer was 19 ft., in some places being as deep as 23 ft., and in sand. Manholes are built at intervals of about 300 ft., or at every street crossing. The district sewers will be 18 ins. in diameter, with 12-in. laterals and 6-in. house connections, and will be on a grade of from $\frac{1}{10}$ to $\frac{3}{10}$ ft. in 100. The entire cost of main sewer was about $50,000, for the payment of which bonds of the city were issued.

Tests of a Compound Locomotive, Union Elevated Railroad, Brooklyn, N. Y.

Some interesting comparative tests of single and compound engines have recently been conducted for the Rhode Island Locomotive Works, of Providence, R. I,, by Mr. C. H. BATCHELLOR, Chief Draughtsman of the works, for the following record of which we are indebted to Mr. JOSEPH LYTHGOE, Superintendent of the works. The correctness of the data and results of the tests are certified to by Mr. FRED. MARTIN, General Manager, and Mr. O. FAIRHURST, Master Mechanic of the Brooklyn and Union Elevated Railroad.

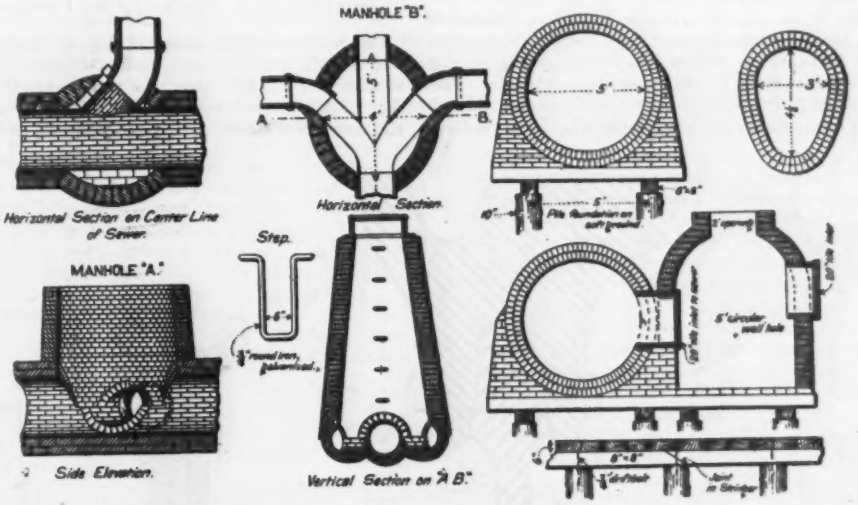
The two locomotives tested were of the following nearly equal dimensions:

LOCOMOTIVE DIMENSIONS.

No.	58	62
Type	Compound.	Simple.
Fuel	Anthracite coal.	Anthracite coal.
Cylinder, sizes, R. S.	18 × 16 ins.	11 × 16 ins.
" " L. S.	11½ × 16 "	11 × 16 "
" ports, steam, R. S.	1 × 17 "	7/8 × 8½ "
" " L. S.	⅞ × 10 "	7/8 × 8½ "
" " exhaust, R. S.	2 × 17 "	1¾ × 8½ "
" " L. S.	2 × 10 "	1¾ × 8½ "
" clearance, R. S.	10.2%	8%
" " L. S.	11%	8%
Steam pipe from boiler, R. S.	2 ins. diam.	3 ins. diam.
" " " L. S.	3½ " "	3 " "
Piston rod diam.	2 "	2 "
Drivers, diam.	42 "	42 "
" rev. per mile	480	480
Boiler, diam.	42 "	42 "
" flues, O. D.	1¾ "	1⅝ "
" " number	121	124
" " length	68 1/16 "	68 1/16 "
Exhaust tip diam.	3 "	3¼ "
Grate, style	Water grate.	Water grate.
" size	54¾ × 41 ins.	54¾ × 41 ins.
" area	15.6 sq. ft.	15.6 sq. ft.
Heating surface	289.46 " "	289.46 " "
" " fire box	45.46 " "	45.46 " "
" " flues	244. " "	244. " "
Ratio, heat'g surf. to grate	18.5 " "	18.5 " "
Steam chest valve, style	Balanced.	Balanced.
" " " full travel	5 ins.	4 ins.
" " " lap o'side	HP. ¾ in., LP. 1 in.	⅝ "
" " " clearance	HP. ¼ " " none	1/32 " lap.
Weight, loaded	45,850 lbs.	45,350 lbs.
" " on drivers	31,534 "	31,084 "
" " on truck	14,316 "	14,316 "

The engines compared were No. 62 simple and No. 58 compound of the Brooklyn and Union Elevated railways of Brooklyn, N. Y. Both engines were of the Forney type, having two pairs of connected driving wheels, with a four-wheel trailing swing-truck supporting the tank, the whole connected to a rigid frame. This design is used to run forward or backward at will. The compound engine was a simple engine rebuilt by the Rhode Island Locomotive Works, so far as the cylinders and their appurtenances are concerned, and is of the two cylinder type, the cylinders being connected by a copper receiver. The cylinder sizes of the compound were designed to do the average service work, so near as it could be judged, with the best economy. The limitations which the size of compound cylinders, designed for this effect, must necessarily bring upon the starting, or even the hauling power of the engine under exceptionally severe conditions, is recognized and provided for by a device allowing the engine to be run at will as a simple engine; the steam pressure in the low cylinder being reduced from that in the high pressure cylinder in direct ratio of the piston areas, irrespective of the boiler pressure. This allows the compound to be used as a simple engine, and greatly increases its maximum power; this becomes necessary in emergency cases only. The possibility of using the engine as a simple engine indefinitely is also a very desirable adjunct for yard work, allowing the engine to be worked to much better advantage. In ordinary circumstances the engine starts from rest as a simple engine, with direct steam in both cylinders, the cylinders having equal power. When the normal pressure in the receiver is reached, by means of the exhaust from the high pressure cylinder, the direct steam is automatically cut off from, and the receiver steam admitted into, the low-pressure cylinder, and the engine thus thrown into the compound system There is thus no appreciable change in power when the change from simple to compound is made, either in changing automatically or on being changed from the cab. The automatic change occurs in from one-half to one revolution of the drivers. The service for which the engines under consideration were designed is of a severe nature for locomotives of ordinary form, and is considered much more so for a compound locomotive, being a series of starts and stops in quick succession, the profile of the line containing many grades and sharp curves, and prompt by performance sheets and competitive trials. The engine seemed in good condition, with the exception of the safety valve, which leaked enough to show steam to a limited extent. The blow-off cock also leaked water; this was measured and accounted for. Compound engine No. 58 had new metallic packing, and leaked badly at the left valve stem. The throttle also leaked considerably. The crew who handled the simple engine formed part of the double crew who had handled it from the time it came on the road, and together with the other crew had demonstrated their expertness in economic running. The management of the engines left nothing to be desired. The compound had been in their hands about 10 days before the test was made, and was run entirely by the reverse lever until the first notch was reached, the throttle being kept wide open. The blower was used but once or twice on the compound and sparingly on the simple. No. 58 was always worked compound automatically while in service.

Weighed coal was used as follows: A new fire was used on both days, the tank was cleaned, and weighed coal put in. The fire was built the night before and banked from coal outside the tank. When the fireman fixed his fire for running about 5:30 A. M. he used coal out of the tank, and continued so to do until the yard was reached at 8 P. M., when the condition of the fire was noted and the coal left



DETAILS OF SEWER CONSTRUCTION, WEST BAY CITY, MICH.

running time being indispensable. The total length of the division on which the engines were run is 5 miles, divided by 16 passenger stations and 2 junction stations, at which stops were required at the time the compound was run on account of a rule issued between Oct. 15 and Nov. 24. Trains consist of two cars during the middle of the day and late at night, and three or four cars during morning and evening hours. The running time is 24 minutes, with a headway of 6 minutes between trains during the two-car trips and 5 minutes during the four-car trips.

The compound engine was run Nov. 24, 1890; the simple engine Oct. 15, 1890. The engines were started from the yard at East New York at 6:15 A. M., and run 6 miles with a light four-car train to Fulton Ferry, where they commenced service, making 22 trips (11 round trips) of 5 miles each, from Fulton Ferry to Ridgewood and return; then 1 trip with four empty cars to East New York 6 miles, making a total train mileage of 122 miles from 6:15 A. M. to 8 P. M. The running time was kept by one watch, time being taken at each terminal; the duration of stops at regular and signal stations was not taken. They averaged about the same, both days being pleasant, the rails good, and the locomotives under trial not being held at signal stations to any unusual extent. The trip at 6:12 P. M. on Nov. 24, however, was an exception, trains being delayed 7 minutes in the busiest part of the day, by awaiting the movements of an extra engine. This necessitated the handling of the exceptionally large number of passengers who had congregated and required extra time at stations. Simple engine No. 62, together with its crews, was selected by the railway company as being the most economical on the road, as judged in the tank weighed back. The state of the fire and steam pressure were similar each day at time of using first weighed coal. Each bucket of coal was weighed by an employé of the railway company. It was all of the same quality and was free from dirt. The size of the coal was broken lump, of a soft anthracite quality. The coal was not wet during the test. The fire was well burned out at the end of each day, especially so on Oct. 15. The ashes were not weighed, circumstances not admitting of it. They showed a very small per cent. of unburnt coal each day. The compound burned its fires with a light draft on all trains. Steam was made very freely, the door being on the latch frequently, even with heavy trains, and especially so with light trains. Engines of the simple class steam freely with a light fire on light trains, but on the three and four car trains the blast is sharp and and fires heavy in order to keep up steam. The compound makes steam with a draft so light and even that it would seem able to burn pea coal with good steaming results, and a further saving in fuel expens.. The quality of coal used breaks up immediately on contact with fire; and on regular engines quite an item is lost through the stack in a bright unburnt condition, in small particles. Quantities can be seen in all places along the road where it can lodge; this dirt becomes disagreeably apparent when standing on the car platforms. The stronger the blast the more this effect. Spark throwing is also prevalent to quite an extent in heavy business hours. The soft blast on the compound does away with much of the waste mentioned, and throws practically no sparks on the hardest service. Continued ooservations on car platforms were conclusive as to the cleanliness of this engine in regard to dirt through

the stack. As an illustration of the softness of the blast, it may be remarked that there was nothing in the smoke-box of the nature of deflecting plates or netting, a clear passage being left from the tubes to the atmosphere.

The water was measured as follows: A barrel was measured as to capacity, and then placed in position so that it could be filled and emptied into the tank readily until the tank was full, the height of water in the tank being taken after each barrelful. Each barrelful made an equal rise of water in the tank, showing the regularity of the tank capacity in height. The various readings of water consumed were made by means of a large float, to the center of which was attached a graduated stick. The difference in any two readings on this stick when compared with top of manhole gave the amount of water used for that time in inches. The readings were made at about the point of the center of gravity of the plan of the tank, and always at the same place on a level track. The first reading was made in the morning at the time the first weighed coal was used, with the water in the boiler just showing in the third gauge. When the yard was reached at night, the water was gauged with the same amount in the boiler, and the same pressure of steam as at the start. During the day the water was measured each round trip at Fulton Ferry, where water and coal were taken, the water being kept at the same point in the boiler at each time of measuring. After leaving the yard in the morning, the water in the boiler of the compound engine was allowed to fall to the second gauge, and was kept there through the day to insure dry steam. On the simple engine the water was kept at three gauges through the day. The overflow from the injectors on each engine flowed into a receptacle, and was measured. Each reading on the gauge stick was checked by the engine driver or fireman.

The tests showed a decided saving in water and fuel consumption, in favor of the compound engine. Aside from the first cost and labor of handling, this saving affects the time lost by the engines in coaling and taking water. The latter is of evident value on limited trains. In the elevated service it enables, in many cases, an engine which reaches the terminal late to save the time that would otherwise be used in taking water, thereby preventing the following train from being held by a signal. This was a fact noticed and commented upon by the train despatcher at the terminal where water and coal were taken. The capabilities of the compound to equal the simple engines, in making short runs, on quick time, were fully demonstrated. This compound, by reason of its ability to be run at will as a simple engine, can equal the maximum power of a simple engine, when the small cylinder on the compound equals in size each of those on the simple, and the steam pressures are alike. The smoothness of running on the compound, as compared with the simple, is noticeable in riding on the engines. The cleanliness of the compound engine from cinders and sparks, and its comparative stillness, are strong points in its favor. The diagrams and other data will be given next week.

	No. 58. Compound.	No. 62. Simple.
Total number trips	24	24
" miles run	122	122
" car miles	353	353
" running time	10 h. 1½ m.	9 h. 57 m.
" coal used	2,430 lbs.	3,899 lbs.
" water used	19,862 lbs.	26,070 lbs.
Gain in fuel over 62	37.7%	.....
Average coal per car mile	6.88 lbs.	11.05 lbs.
Gain in water over 62	23.8%	.....
Equivalent evaporation from and at 212°	9.97 lbs.	8.09 lbs.
Equivalent evaporation from 58° to 140 lbs. pressure	.....	6 69 lbs.
Equivalent evaporation from 58° to 155 lbs. pressure	8.25 lbs.	.....
Average water per car mile	56.27 lbs.	73.85 lbs.
" with 3 and 4 car trains	48.11 lbs.	65.06 lbs.
" with 2 car trains	71 14 lbs.	89.89 lbs.

(To be continued.)

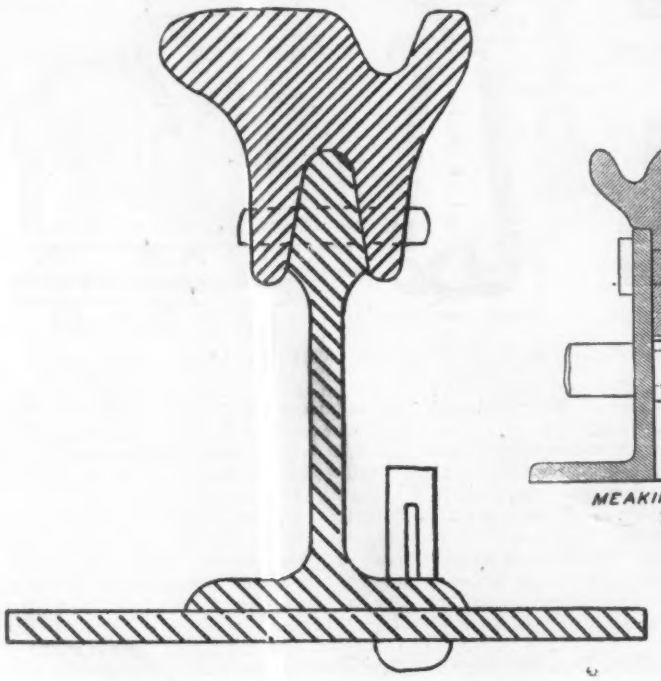
Four Styles of Engraving Rail Sections.

Our readers will have noticed that on more than one occasion lately we have hinted or plainly stated that more strict attention was required in the conduct of the business management of the affairs of the American Society of Civil Engineers, and that the publication of the Transactions of the Society especially was conducted upon methods that were at once wasteful and discreditable. This, however, has been denied, both in personal communications to the editors and in a recent circular issued to all members, and we have been challenged to point out any such deficiencies. It is proper that we should do this or withdraw the charge, and we do it by taking as our text the last paper published by the Society, that by Mr. T. GRAHAM GRIBBLE, read Dec. 17, and abstracted in these columns last week. We select this, not as anything exceptional, but merely as the latest example of methods which are not exceptional, but which will be found to exist throughout the publications of the Society for some years past, at once injuring their appearance and greatly increasing their cost.

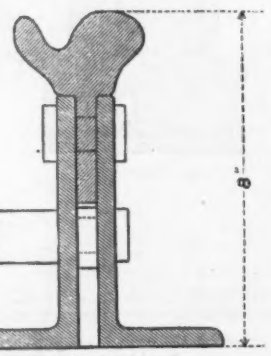
To properly understand the facts which we desire to make clear, however, it will be necessary to explain first a few elementary facts about modern engraving processes, which will be of interest to many readers for their own sake.

Nearly all modern engravings, from the simplest to the most complex, are made by the so-called photo-engraving processes, by which any drawing in black and white is reproduced as a whole, photographically, as in blue-printing. Unlike the blue-printing process, however, the photo-engraving process permits of readily changing the scale of the original drawing in the process of reproduction, just as a photograph of the human face may be made of any size from an inch to 2 ft. high and still preserve all the details of the features, the enlargement or reduction being always proportional. But in enlargement all defects of the face or of a drawing are exaggerated, while in a reduction they are diminished.

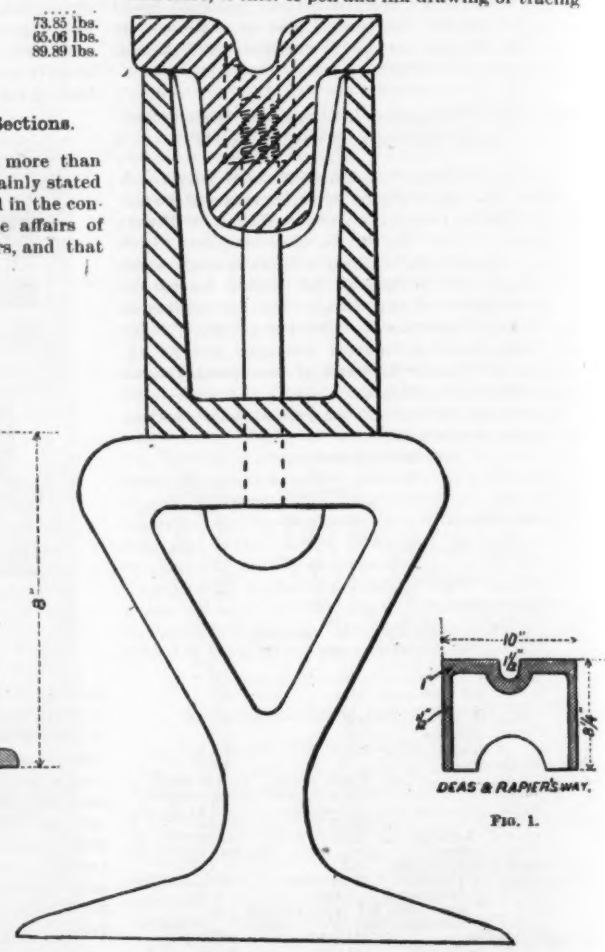
The practical process of making engravings, therefore, is this: A pen and ink drawing or tracing of any convenient size is first made, which may be of any size from one-fifth to five or six times larger than the engraving to be finally made for it. There is hardly an issue of this journal which does not contain examples of reductions between these extremes. Some little reduction is always desired, because it sharpens the lines and gives a more finished effect. Large reductions require extremely bold lining and lettering, something like Fig. 5 above. Taking a look at Fig. 5 through an ordinary reducing glass, it will be seen how readily such bold, coarse work reduces, and when reduced, produces the effect of quite fine work. To reduce by all sorts of amounts and still preserve a general similarity of lettering



PAGE'S REMOVABLE RAIL
Fig. 16.



MEAKIN'S RAIL.
Fig. 10.



DEACON'S REMOVABLE RAIL
Fig. 5.

FOUR STYLES OF ENGRAVING RAIL SECTIONS.

Reproduced as example of style from the engravings accompanying the last paper read before the American Society of Civil Engineers, that by Mr. T. Graham Gribble, abstracted last week.

and effect in the final results, however, requires that the thickness of the lines, and above all the size of the letters and figures, should be carefully studied. When the reduction is large the figures and letters have to be exceedingly large and bold. Hence the necessity for the instructions for preparing drawings which usually appear at the head of our editorial page.

When a drawing is taken in hand for engraving by a careful editor, therefore, the first thing done is to determine about how much it can be reduced and remain perfectly clear, which depends upon the amount of detail on it, and the second thing is, to fix the precise reduction so that it may conveniently fit the page, or a column, or two columns. This is determined for a whole batch of drawings in a few minutes and written on each. The drawing is then traced in style adapted to the specified reduction, and, when finished, sent to the engraver, a batch of the originals being to all appearance drawn in very different styles, to the end that the final engravings may be in nearly uniform style. Otherwise the reverse will be the case.

The engraver then pins up one or more of these engravings requiring a common reduction, sets his camera to give it upon a sensitized coating of gelatine, and finishes his plate by mechanical processes only, except that he occasionally touches up an imperfect line or letter. The photo-lithographing process is analogous in all essential respects.

As naturally follows from the nature of the process, the charges of the engraver are so much *per square inch* (usually 10 to 15 cts.), regardless of what is on that inch. A 6 × 8 plate measures 48 sq. ins., and costs say $6, whether that plate contains merely a single diagonal line, a few scattered dots or a most elaborate drawing. Furthermore, the dimensions measured by the engraver are the extreme width and height, with no deductions for parts cut away.

It will further be seen that, if an engraver be left to himself to choose a scale of reduction, he will naturally make it as large as possible, since his price increases as the *square* of the scale, while it costs but a fraction more to make it large scale than small. For example, Fig. 5 above measures 5¾ × 3⅛ ins. = 19¾ sq. ins. Had the lettering under it been reduced to the width of the rest of the cut it would have measured 5¾ × 2 1⅜ ins. = 16⅛ sq. ins. Had it been reduced to one-fourth of its present size (which would even then leave coarser hatching than in Figs. 1-10) its area and cost would have been only ⅛ part as great.

Moreover, when this cut comes to be printed, it is again charged for by the printers at the same price as if the space occupied by it were set up with solid type. There is ordinarily no deduction made for space occupied by cuts in the composition; so that the loss from needless size is (1) the cost of the cut, (2) the rough appearance of it, (3) the extra paper required to print it, (4) the extra composition charge.

Finally, the size of the page being fixed, if no pains be taken to bring engravings to a size which will fit it, so far as possible, the only remaining resource is to put in what is called an "inset," a folded sheep of paper printed on one side only, but which of course may be made of any size desired, or which it chances to come, by making enough folds. Hence there is an obvious temptation to the careless editor to use insets freely; but they are not only expensive, but deface the volume, if numerous, and hence are to be avoided.

These general facts being noted, we return to the particular case in question. A series of a dozen or so different drawings of street railway rail-sections was turned in to be engraved in connection with the paper. Of this dozen we produce but four, but all the rest are in the same style, and some of them even more striking examples of it. These original drawings were all in the bold and careless style of Figs. 5-16. The most obvious and simple requirement was to first fix some uniform scale for all the drawings to be reduced to, as could have been done almost in a moment. This was wholly neglected. The drawings as received were turned over to the engraver to work his will with them, and he made hardly any two of them alike, and most all of them absurdly large.

The second error lay in carelessly permitting most of these drawings to appear without any dimensions or scale on them, thus destroying a large part of their value as a record. The author should have been asked to supply this omission, which is conspicuous on most of the drawings of the paper. The third error lay in leaving on the very rough lettering beneath the cuts, which, if engraved, is paid for twice over, while it was too rough to appear at all. The fourth error lay in using these rough original drawings at all to engrave from. They should have been first redrawn in better style, which in the long run saves all that it costs by permitting of reduction to smaller scale without sacrificing clearness. This journal would not permit such drawings to be used to engrave from, and it would appear as if the standard of the Am. Soc. C. E. should be at least as high as ours, if not higher.

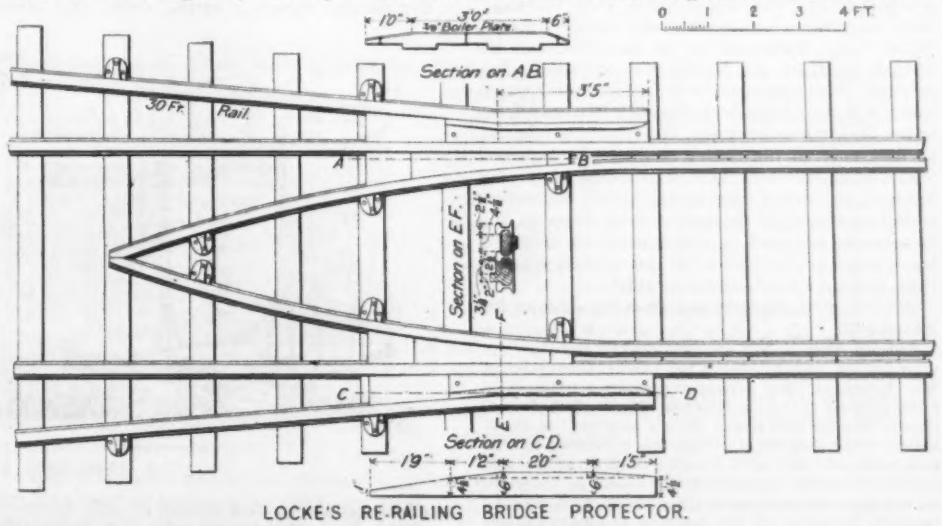
The fifth error lay in using no less than three large insets for this one paper, all of them needlessly large, all of them poorly drawn, all of them lacking many desirable details and dimensions, and all of them easily dispensed with altogether had the originals been redrawn in good style, and then properly reduced to a size which would go on the page. These insets are respectively 9½ × 13 ins., 10 × 14 ins., and 19 × 13½ ins. The whole matter on them could, with the greatest ease, and with great improvement in style, have been given on four pages of the Transactions, requiring only one-fifth as much paper to present them.

Since this article was in type the last two issues of the Society Transactions for October and November, 1890, have been issued to members. The justice or injustice of the preceding criticisms may fairly be measured by these two issues. Much more than two-thirds of their bulk is made up of plates, which number not less than 46 in all to illustrate 122 pages of text, 27 of these being folding plates, many of them of enormous size, and almost every one of them capable of easy reduction to half or a quarter of their present scale. Moreover, no evidence is visible on any of these plates of an effort to preserve a high or uniform style of execution.

These facts will make clearer one of many reasons why we have felt it a duty to take a decided stand on the pending question of a radical change in the future management of the society.

Locke's Rerailing Bridge Protector.

The accompanying engraving, for the original drawing of which we are indebted to Mr. A. W. LOCKE, of North Adams, Mass., shows a bridge protector which was designed by him and put in use in its



LOCKE'S RE-RAILING BRIDGE PROTECTOR.

main features in 1879; about 30 of them having then been laid down by Mr. LOCKE on the Troy & Greenfield Railroad and Hoosac Tunnel line, now a part of the Fitchburg system. These bridge guards are still in place, and Mr. LOCKE informs us, that, "although severely tried, they have never failed to do their duty so far as known." The guard rails extend entirely across the bridge 2½ ins. from the gauge line. That part of the outside casting which is raised above the track is a late improvement, and is intended to carry the wheel on its tread until the flange is landed on the top of the track rail when the guard rail on the other side pulls it into place.

Mr. LOCKE adds:

This has always seemed to me to be a pretty good bridge protector. If any important defects are visible, I would like to have them pointed out.

The discussion of the bridge safety devices proposed by Mr. MCNICOL in ENGINEERING NEWS of Oct. 4, was noted with interest. As this device, however, in the case of through bridges, requires a much greater clearance than is otherwise necessary, it would seem that some other arrangement is desirable.

The device illustrated differs in no important respect from the Latimer safety guard, although it appears to be an independent invention, and it is therefore almost needless to say that we are disposed to think highly of it, as a device which can in no case do harm (at least if the outside guard is carried out far enough), and will in most cases do great good at the critical moment, when speedy disaster is otherwise almost certain. The details of the device differ slightly from the Latimer guard, but hardly enough so as to make a measurable difference.

Early English Railway Humor.

While in England during the past summer we happened upon some old volumes of a humorous paper, which contained notes upon the railway topics of the day, and these notes suggested to us the preparation of an article upon early railway humor for publication at the Christmas season. The paper in question was *Punch, or the London Charivari*, the leading English humorous paper, and in looking through the volumes of 1845 to 1850, which include the period of the rise and collapse of the railway mania (ENGINEERING NEWS, April 12, 1890) one is struck with the historical interest of the various sketches, skits and jokes on the railway question. When railways began to be introduced in England they offered a new subject to the professional humorists, of which they were not slow to avail themselves. At first they began by ridiculing the ideas of those who were endeavoring to introduce railways, but later on, when the railway had been established as a practicable and successful institution, they devoted their energies to joking upon and satirizing the numerous faults and defects of the system, much in the same way as is done by the humorists of the present day. In fact, it will be easily noticed that some of the subjects then selected for points of attack are still in very general use; among these may be mentioned the provisions, charges and service of railway refreshment rooms, the insufficient time given for refreshment, and the incivility of railway employees. It is very interesting to look through these old volumes, and the extracts given in this article are but a few selections from many sketches and notes on railway topics.

The Railway Moral Class Book. (By the Bishop of London.) Morals for the First Class.—The morals presented for this class are the same on all days of the week. An act which is moral on Mondays, Tuesdays, Wednesdays, Thursdays, Fridays and Saturdays is moral also on Sundays. The reason is that this class employs the best tailors, eats the best food, drinks the best wines, in fact lives the best, and, lastly and especially, pays the highest fare of all the three classes. Moreover, being accustomed to amuse themselves all the six days of the week, it would be cruel to deprive them of recreation on the seventh; and having little or no business on any day, they have as much business to travel on Sunday as on any other.

Morals for the Second Class.—It is not, strictly speaking, quite proper for persons of this class to do the same thing every day; so that a perfect system of morality would prohibit them from Sunday traveling. Many of

them go to Holborn and the city for their clothes, dine upon two courses, and cannot afford hock, clarat and champagne, or even good port and sherry. However, on the whole, they are pretty respectable. Thus, for the transgression, the rigid rule of right may be relaxed, and they may be permitted to travel on Sundays; but they are to understand this permission as a sufferance merely, and their conduct in availing themselves of it is by no means to be approved of.

Morals for the Third Class.—For this class of people to travel on Sundays is a heinous crime. They are meanly clad, and live upon a coarse kind of food. Toil and hardship are their portion during the week, and enjoyment on the Sunday would make them discontented with their lot. The third class of railway passengers is formed of the inferior classes, and, not being respectable, no respect whatever should be shown to its inclinations. Its fare is nothing like an atonement for the crime in question. The Legislature, therefore, has acted very improperly in compelling Sunday trains to run third-class carriages, and the statute, if possible, should be evaded.

The state of affairs shown by the above sarcasm is entirely changed now, the third class paying the companies best, while many of the best class of people ride in third class cars.

In 1845 there was the following poetical allusion to the open cars then still in use for third class passengers:

The Third Class Travellers' Petition.

Pity the sorrows of a third class man
Whose trembling limbs with snow are whitened o'er,
Who for his fare has paid you all he can;
Cover him in and let him freeze no more.

This dripping hat my roofless pen bespeaks,
So does the puddle reaching to my knees;
Behold my pinch'd red nose—my shrivell'd cheeks;
You should not have such carriages as these.

Keen blows the wind; the sleet comes pelting down,
And here I'm standing in the open air!
Long is my dreary journey up to Town,
That is, alive, if ever I get there.

Oh! from the weather, when it snows and rains,
You might at least defend the Poor;
It would not cost you much, with all your gains;
Cover us in, and luck attend your store.

The character of many of the schemes proposed is shown by imaginary prospectuses in satirical imitation of many actually issued. One of the most humorous pieces on this point, however, is a bona fide extract from the prospectus (1845) of the Somerset & North Devon Junction Ry., a line proposed for a remote and almost uninhabited section of country. The extract refers to the early invasion of Britain by Hubba, and states that should any other invader ever land there the railway could bring down troops to drive him away. *Punch* gives a prospectus of "The Great North Pole Railway," from the horizon, passing over the equator, to the North Pole. Sunbeams to be conveyed, and ice brought up from the North Pole to the London market. Also a prospectus of "The Grand Antipodean and Hemispherical Junction Railway," between Glasgow and Sydney; this line to be carried at first only to the center of gravity; all trains would be down trains until a magnetic apparatus has been completely organized. "There will be fast trains running right through without stoppage, the momentum acquired in the descent of the down trains being quite sufficient to convert it into an up train without any additional power."

The following extracts are from the volumes for 1845 to 1850:

Railway Shares.—We are requested to state that applications for railway shares are carefully executed at Mr. Montague Tigg Scribleigh's superior penmanship establishment, in Leicester Square. Mr. M. T. S. flatters himself he could lend a hand to any attorney, or stockholder, who is desirous of getting up a railway for the public benefit. Mr. M. T. S. makes it an invariable rule never to fill up two applications for shares in the same railway with the same pen or ink. Mr. M. T. S. uses the greatest discretion in the selection of names and addresses, and he is proud to say he has got at his fingers' ends every variety of aristocratic, legal, clerical, literary, and mercantile letter-writing. Mr. M. T. Scribleigh takes the liberty to state, as a proof of his qualifications, that out of a hundred letters furnished by him to the Dublin and Galway Railway, not one was rejected by the Directors. A court guide kept on the premises, and a valuable set of autographs to refer to. No extra charge for a bishop or a duke. (1845.)

Railway Lunatic Asylum.—"In the present age of enlightenment," as our tea-dealer says when he wants us to try his three-and-sixpenny mixed, which by-the-bye, we have tried, and we don't like it—"in this age of enlightenment," we are surprised that the public spirit which pervades everything should be neglecting the demand that must eventually arise for an Asylum for Railway Lunatics. We think that the insanity, which must be in existence, to start the variety of new, impracticable and useless schemes that are already suggested will eventually require some vast asylum to contain it; and we congratulate Parliament on having passed lunacy laws just before they were wanted. We give a design for a Railway Lunatic Asylum, which should be a kind of general terminus to many of the new schemes that are advertised. (1845.)

How to Make a Railway.—Take a sheet of foolscap paper and a *Court Guide* for 1790. Pick your Lords and Right Honourables add half a dozen ex Members of Parliament, and season with a few merchants and F. R. S's. Then throw in an engineer, a banker and a lawer; garnish with imaginary advantages and serve up in an advertisement. (1846)

Railway Gardening.—With a view to standard fruit, cultivate good trunks, but keep clear of all unprofitable branches. Take care that the stock is of the right sort, or

"Poor Sweeper, Lawd! Railway Director, coch, Lawd!"

After the Railway Mania of 1845

it will not be worth putting in, and will not pay for the outlay. Do not scatter your money broadcast, but sow in good regular lines, unless for immediate use, when you may plant anywhere; but you must be prepared for clearing out and getting in the crop as quick as possible. (1846.)

The Railway Share Market.—A slight rise in the price of waste paper has given an impetus to almost every description of railway shares, and there is no doubt that when some of the heavier stock—the coarse cartridge paper—has been cleared off, the heavier railway stock will sympathize. (1850.)

A not improbable result of this inflation and collapse is shown in the cut of the railway director reduced to beggary, which we reproduce from *Punch*, Dec. 27, 1845. Another picture represents several directors who have been compelled to earn a living by acting as cabmen and using their carriages for hire.

For railway signals, a rattle, drum and steam trombone are shown (in a number for 1847) mounted on the engines. Railway races are quite frequently suggested as a substitute for horse races, and the following paragraph shows that English railway track was not as good then as it is now:

Railway Sports and Pastimes.—Steeple-chasing will be destroyed by the railways; but for those addicted to that hazardous amusement, let a certain number of the lines be left in their present condition, which will still place the sport of risking life and limb at the command of all gentlemen who are fond of it. (1846.)

Sale of a Steam Stud.—1. "Burster." A fast, narrow-gauge, long-boiler engine, by "Stephenson," out of "Experiment." Warranted safe, with a steady stoker, but apt to run off the rails when extra steam is put on. 2. Vesuvius, by "Dividend," out of "Economy." Aged. Has been worked a short time on the North Midland Line. (The stoker absolutely refused to run him without a safety valve. Put up very cheap and bought for an amalgamation line for a trifle.) 3. "King Death," by "Express," out of "Recklessness." This was the well-known engine which had already killed three stokers, four first-class passengers, and two-thirds of a parliamentary train full. Temper said to be vicious, and a screw loose in the boiler. (1847.)

In the large cut of "A dumpy leveler outwitted," which we reproduce from *Punch* almanac for 1846, the leveler illustrated is using his "dumpy" level at a period when farmers and country people generally were very strongly opposed to railways, and tried in various ways to obstruct or prevent surveys across their property. Land owners were not then so opposed to them, as the railway mania was just beginning, but the country people and laboring classes still looked upon the railway as a ruin to labor. From the skits referring to engineering features we select the following, the first being a shot at the style of evidence given before Parliamentary committees by the "engineers" for the promoters of new schemes. In the second the use of the word "railroad" will be noticed:

Engineering Evidence.—Q. Now, sir, please explain the engineering advantages of this line in your own way.

A. It is obvious that if I take a mean isosceles triangle of three-and-quarter, it gives a gradient of five to the square inch; and thus tunneling will be avoided through at least one-half of the line.

Q. But how about the embankments?

A. If I cut a square inch out of a rhomboid, and throw it off at right angles, it is clear that there can be no support to the sides. If, on the other hand, I establish a fulcrum on the surface of a spheroid plane, it is impossible that the embankments can fall in; and this, I take it, is the great advantage of the proposed line.

Q. Do you think a gradient of two will be sufficient?

A. Certainly I do. If I had a lever and a screw now in the room, I would undertake to show in five minutes that a patent axle, working on a broad gauge and going consecutively in rotation after a double stuffing box, would be of itself sufficient to do all that is required. (1845.)

The Surveyor's Return.—Faint and wearily the way-worn Surveyor returns to the bosom of his family. He has finished his railroad labors, and they have nearly finished him. Six months ago he went forth, erect, elate, plump, rubicund; even as a boxer trained for the fight. Elastic was his step; his air was jaunty. Tight was the fit of his shooting jacket; and sprucely did he look in it—for it was new. Unworn were the highlows which he marched along in, shouldering his theodolite, or brandishing his trusty level. Behold him now! His head droops, his form is angular, his cheek is sallow; he is like unto a pauper newly emancipated from the workhouse. Loose are his garments; patched also, and shabby; and low as his condition are the heels of his boots. His level peeps timidly from his hinder pocket, and he trails his theodolite

A Dumpy Leveller Outwitted. Dumpy *Loq.* "Why, if he hasn't put up a table-cloth."

A LEVELER'S TROUBLES IN 1845.

on the ground. . . . Surveyor, a word in thine ear: Thou hast accomplished thy work; and the labourer is worthy of his hire. We would advise thee as a friend—a familiar friend—to look sharp after thine. Make out thy account speedily; send in thy bill with all despatch, while yet the bubble is roseate, and the Jeremies who blew it, whose surname is Diddler, yet linger in the land of the solvent; and ere, borne far away o'er the broad Atlantic, the rogues of the railways have sought the realm of the Repudiator. (1845).

The extent of railway surveying has caused a certain popular query to be superseded. Instead of "Has your mother sold her mangle?" the boys in the streets now ask, "Has your father sold his theodolite?" (1845.)

Symptoms of a Panic.—Pawnbroker (to applicant): Now, sir; how much do you want on this theodolite? (1846).

Engineer (at level).—Don't be alarmed, ma'am, it's only a dumpy leveler.

Old Lady.—Law! Dear now! Well, I'm sure I thought it was a blunderbust. But don't fire it off young man, till

I'm got by, for I was always terrible feared of guns. (1848.)

A Mockery, a Delusion and a Snare.—We perceive by the railway intelligence of the past week that one of the large companies has given its resident engineer a portrait of himself and £500 worth of stock at par. Considering that everything in the railway world is now at a tremendous discount, the presentation of anything at par to anybody is like giving him a ravenous bear, for it is ten to one that the shares will eat him up in future calls, to say nothing of the actual difference between accepting at par what may be already at discount. The portrait may give the affair a different complexion, and at all events it is better to be done in oil than done in railway securities. (1850.)

Suggestion for Elevated Railway. *Punch*, 1846.

The man who, in 1846, conceived the idea of the elevated railway, which he sketched and described as a satire upon some of the absurd schemes then being put forward, little thought that he was so good a prophet. We reproduce his sketch, and the following is the description of the proposed plan:

The Latest New Railway.—Every scheme appeared to have been exhausted for devising a new style of railway until a plan, to which we are about to allude, was happily hit upon. We have had suggestions of subterranean railways, to go tunneling through our coal cellars and viaducting over our balconies; but these might have caused inconvenience, which will be altogether prevented by the new Shop-Ledge Line, which is to be obtained by making all the shop ledges in the same street of an equal altitude. The vehicles may be ordinary vehicles, with a sort of telescopic axletree, made to draw in and out at pleasure, so as to be accommodated to the width of the thoroughfare. This plan would cause considerable relief to the overcrowded streets, if tried in some of the most frequented parts of the city, for a traffic could be going on overhead simultaneously with that on the lower level. The expenses of the construction of such a line would be exceedingly moderate, as it would only be necessary for each shareholder to raise or lower the ledge over the window on the ground floor to the same height as those of his next door neighbor's. It would not be necessary to purchase any ground, except for the purposes of termini. Had such a thing been proposed a year ago the applications for shares would have been overwhelming. As it is, we think there may be a fair demand if the scheme is properly advertised.

THE MAN WHO NEVER LOSES.

CERTAINLY, MR. HUDSON is a wonderful man, for, according to the papers, he has won another sum in the railways of £150,000. Speculation with MR. HUDSON seems to be a winning game. Every card he plays turns up trumps. It would be curious to calculate the entire amount of his winnings this year. It would be something under a million, if not beyond, for his gains are always of a most colossal size. He is never content with anything less than £100,000, which seems to be as little to him as if you were to give a Spanish Bond, by way of Christmas Box, to ROTHSCHILD. He will be at a loss to know what to do with his money. We shall see him, one of these unhappy days when everything is below par, buying up half-a-dozen bankrupt railways, and being chairman, directors, shareholders, and everything himself, which will certainly be the best way of "making things pleasant," as he will have no one else's accounts, or goose, to "cook," but his own.

But all business, without some kind of amusement, grows very oppressive. We recommend MR. HUDSON, therefore, as soon as he has won a few more hundred-thousands, to try his hand at a little harmless fun. Why should he not, "just for the lark of the thing," carry out the testimonial that was never presented to him? He would only have to pay up the subscriptions. Suppose they cost him £90,000, or even a million, what is that to a man of his enormous wealth? He would then only have to purchase some costly work of art, to give a grand party, and to present in a glowing speech the HUDSON Testimonial to himself after dinner. Depend upon it, the joke would be tremendous, besides being a glorious satire upon the humbug of testimonials in general.

Hudson, "the Railway King"

Mr. HUDSON, "the Railway King," comes in for a share of attention, and we reproduce from one of the January numbers of 1851 a cut and paragraph referring to him, in which his downfall is predicted.

And finally we give a few short squibs which we have found scattered through the volumes, with a few of the quaint conceits which embellished the pages of the *Punch* almanac for 1846.

The first idea of railways is of very ancient date, for we hear of the Great Norman line immediately after the Conquest. (1846.)

Laborer (to pard): "This ain't such a wery bad idea, is it, Jim? Here's the Great Diddlesex writes me for five bob on a hundred an' fifty shares; and, to save trouble, vants the name of my solicitor." (1846).

A New Railway Nursery Song.—"Tinker, tinker, sue tailor; tailor, tailor, sue cobbler; cobbler, cobbler, sue doctor; doctor, doctor, sue captain; captain, captain, sue colonel; colonel, colonel, sue parson; parson, parson, sue Board of Directors to get back money paid for shares not worth one halfpenny.

A Rhyme for the Rail.

Goods and mail were on the rail
And mail pulled up for water
Goods, slap-dash, ran in—crash! smash!!
And express came rattling after.
(Almanac, 1852.)

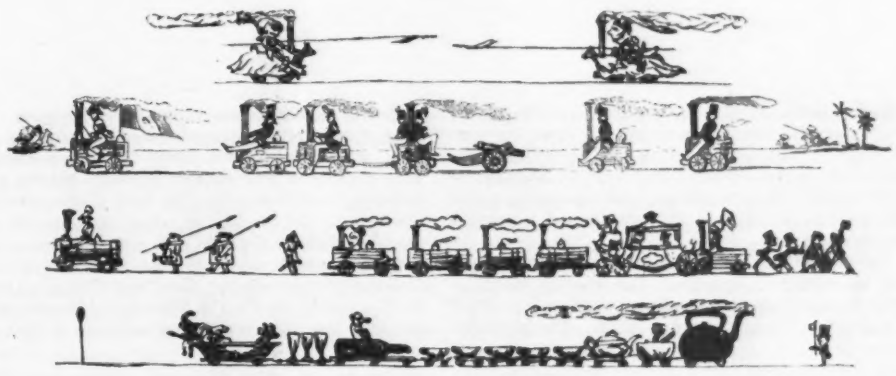
Railway Director's Nursery Rhyme.

Hushaby baby, asleep in the train
When we spare wages, so much we gain,
When we're ill-served, collisions befall,
And smash go carriages, baby, and all. (1800.)

The Vestry Fiat.

To your new-fangled ways and means,
We still prefer our stale ways;
We'll neither have street railway trains
Nor yet have TRAIN's street railways. (1802.)

A French dramatic author was talking about *succès d'estime*, when an English engineer suggested that the



railway locomotive was the greatest *succès de steam* that he had ever known. (1863.)

Railways.

For aught that ever I could read,
Could ever hear by *Times* or *Chronicle*,
The course of railways never did run smooth:
For either it was difficult in curves,
Or else the gradients were "unkimmon" steep,
Or else it stood upon Directors whims;
And "if" the calls *were* paid, and the line done,
Explosions, accidents lay hold of it
Swift as the telegraph, short as dividends;
Brief as the lightning when it greasy is,
Or like the steam that travels o'er the earth,
That, ere the stoker can aloud cry "Ease her!"
The boiler bursts and blows us up,
So quick upon the rails we meet contusions. (1847.)

The St. Clair Tunnel.

VI.

Preceding articles published Oct. 4, Nov. 8, Nov. 22, Dec. 6 and Dec. 20.

GENERAL PROGRESS OF THE WORK.

From the time work began on the tunneling until the last ring of lining was in place, the work went forward day and night, Sundays and week days, without interruption. The men worked in three 8-hour shifts, and the complete duplication of the machinery precluded all necessity of stopping for repairs or breakdowns. The total number employed about the works during the tunneling averaged about 75 for each shift. The gang working in front of the shield, excavating the clay and loading the cars, numbered 26, and 15 men were employed in placing and bolting the iron lining.

The methods of working varied somewhat, according to the nature of the ground. Where the clay was fairly firm and there were no indications of water or quicksand, the whole area in front of the shield was dug away for two or three feet in advance of the cutting edge. On the other hand, where very soft material was encountered, the clay would run in from above the line of the tunnel if this course were adopted. In such places the shield was kept close up to the working face or was forced into it. Indeed, at times, in very soft ground, all the workmen came to the rear of the shield, the hydraulic pressure was turned on, and the big cylinder was pushed into the soft mass, which filled the whole interior and came rolling back through the bulkhead doors, where it was shoveled up.

All the time of one man was devoted to boring in advance of the excavation. A 6-in. auger was used and five or six holes scattered over various parts of the working face were kept about 10 ft. in advance of the excavation. This gave both engineers and laborers great confidence in the safety of the work. Gas and quicksand were the things most feared; and it was pretty certain that no dangerous vein of these would be struck without warning from the advance borings.

Mr. HOBSON made extensive inquiry for a simple and reliable test to indicate the presence of gas, but could find none anywhere. Reliance was placed, therefore, on the Davy safety lamp and the air in front of the shield was frequently tested with this, near the floor, near the roof, and on different parts of the working face. While the lamp never gave noticeable indications of the presence of gas, it is believed that considerable quantities did enter the tunnel at times, and it was owing to its rapid diffusion because of the ample ventilation that its presence was not apparent. Many seams of gravel were found which had the peculiar blackened and discolored appearance which is caused by the presence of gas.

The clay through which the tunnel passed contained many boulders, sometimes weighing several tons. Until work began with compressed air, those too large to be handled were blasted in front of the shield. Afterward a different course was pursued. In good ground the easy plan was adopted of digging a hole at the side of the tunnel and rolling the troublesome boulder into it. Where this could not be done, the boulders were split with plug and feather until small enough for transportation.

The softest clay was met with in the land portions of the tunnel before the air pressure was used; but under the river near the Canadian shore a 20-ft. seam of gravel, supposed to be due to the movement of the clay in filling the old preliminary drift, was passed through. This porous seam gave much trouble from the air blowing out into the river above, and it was necessary to keep part of the working face plastered with clay at times to check the escape of the air.

The material excavated weighed about 125 lbs. per cu. ft. and was exceedingly difficult to penetrate because of its tenacity. The very interesting story of how the problem of rapid excavation was finally solved is told in an editorial note in this issue.

A curious phenomenon was observed with regard to the movement of the shields. While these could be guided as respects their axial direction to keep them on the line of the tunnel, as already explained, no provision was made to prevent them from revolving about this axis. The American shield, which was started in July, 1889, revolved until February, 1890, the top moving toward the north, and it was then about 20° from its original position. It then began to revolve in the opposite direction, and by Aug. 30, when the tunnel was completed, it had passed its original position and gone about 30° to the south. The shield on the Canadian end re-

volved to the south from the very first; and when the two shields met edge to edge their departure from their original vertical position was almost precisely the same, so that the horizontal partitions met edge to edge.

This revolving of the shields was through too small an angle to interfere at all with the work; but if the American shield had continued its revolution in the same direction during the whole progress of the work it would have made some inconvenience. No satisfactory explanation as to the cause of the shields' rotation has yet been assigned. Whatever the cause, the motion seems possible of occurrence to a considerable extent, and it may be well to provide for controlling it in the design of future shields.

It was also observed that the tunnel lining which was started with the key exactly at the crown, was finished at the close with the key some distance to one side. This, however, is a matter of small importance. It was probably due to slight inequalities in the cored bolt holes, which by the screwing up of the bolts all in the same direction formed a "cumulative error."

The accompanying profile shows the progress of the tunneling by months. The average monthly rate of progress in the American heading was 236.4 ft.; in the Canadian it was 219 ft. The greatest monthly record was made in the American heading in July, 1890, when 382.30 ft. advance was made, or an average of 12.33 ft. per day. The record of single days, however, was much in advance of this. Occasionally 10 rings of lining were placed in 24 hours, which was an advance of 15.3 ft., or at the rate 107 ft. per week. A greater weekly advance than this was recorded on the new Croton Aqueduct in one or two instances, but it was on a much smaller heading. Taking the rate of progress of the whole work from the dates when tunneling commenced, it is safe to say that no tunnel in any material was ever driven more rapidly, taking into consideration the very large cross-section. The following table gives the progress for each month from the time tunneling began:

Months.	Canadian heading.	American heading.
1889.		
July	.....	53.00
August	.....	141.05
September	73.30	153.70
October	109.45	126.75
November	187.50	225.50
December	217.40	266.91
1890.		
January	292.35	277.59
February	306.08	273.67
March	292.50	303.63
April	281.34	182.20
May	97.00	355.54
June	236.83	354.46
July	201.30	382.30
August	334.04	311.11

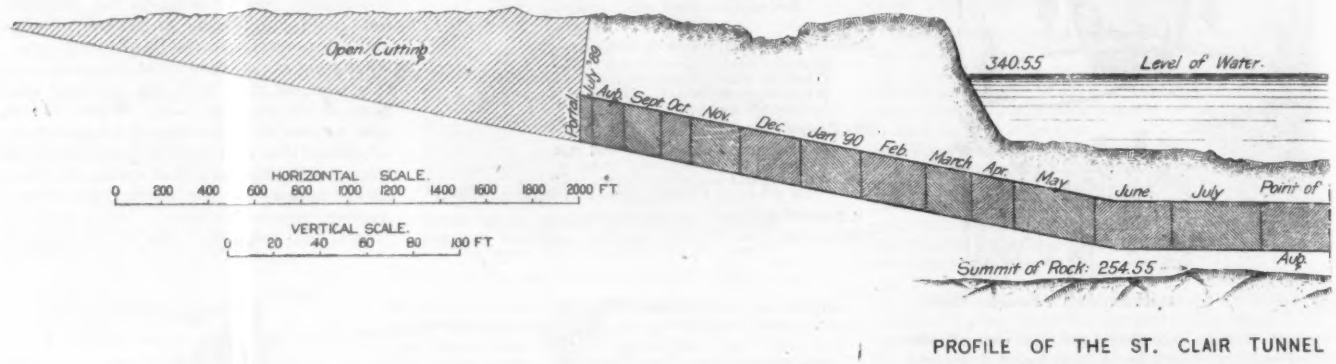
When the shields came within 125 ft. of each other a 6-ft. drift was run from one to the other, lined with pine blocks cut in the shape of voussoirs, 2 ft. long and with a cross section about 12 ins. square. On Aug. 23 but 15 ft. of clay separated the working parties. An auger hole was bored through this and a plug of tobacco was shoved through, which may, perhaps, be considered as the first traffic through the tunnel. On Aug. 25, at noon, an opening was shoveled through the thin wall still remaining and Chief Engineer HOBSON, Mr. MACKENZIE, one of the directors of the company; the Chief Medical Officer, Dr. JOHNSTON; Mr. EAMES, Mechanical Superintendent, and Mr. MURPHY, Superintendent of Excavation, walked through from the American side to the Canadian. At the same moment the signal was given outside, and every steam whistle in Sarnia and Port Huron gave a blast in honor of the completion of the work.

Through this drift the position of the shields was verified, and excavation of the short distance remaining was completed on Aug. 30. At 11:30 P. M. the edges of the two great shields came together, having slid through the clay beneath one of the greatest rivers on the continent a distance of 6,000 ft.

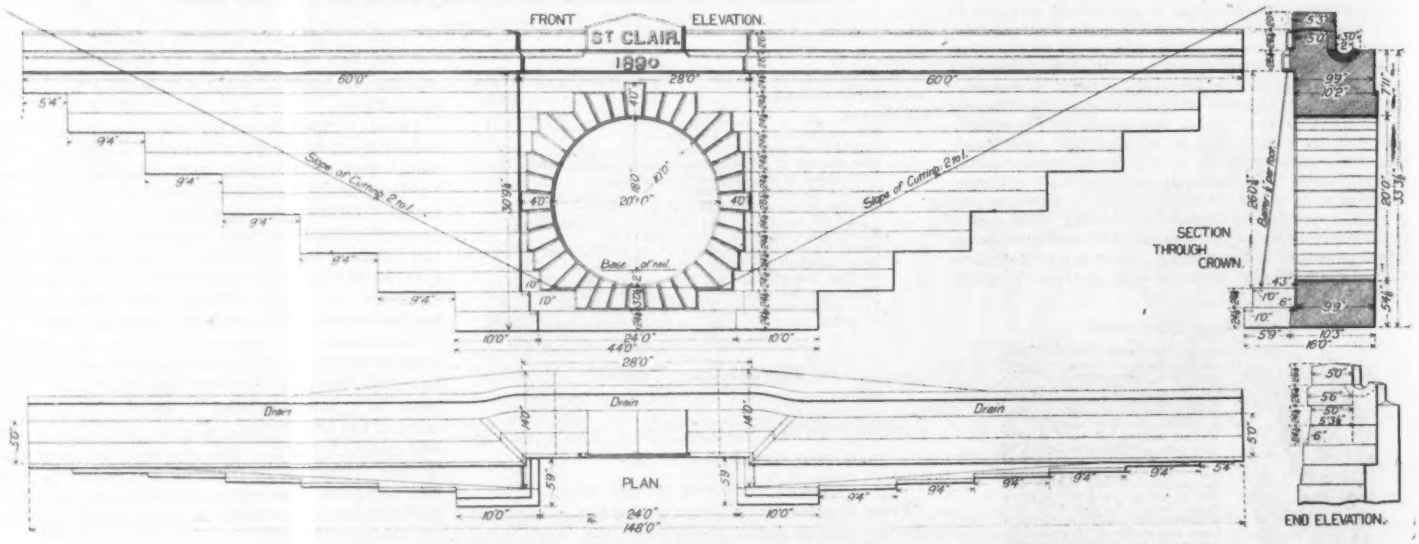
It was not deemed best to expose the work to even slight chances of disaster by attempting to remove the shells of the shields. The partitions and bulk heads were cut away, therefore, and the cast iron lining was completed, leaving the shells in the clay outside. The last ring of lining put in was specially cast to fit the space left.

After completing the lining, work was at once begun clearing out the clay which had been filled in the bottom of the tunnel, caulking a few places where leaks developed at the circumferential seams, and putting the tunnel in shape to receive the brick and cement lining and the railway track.

Work on excavating the long approaches to the tunnel had been delayed until the success of the enterprise was assured. The contract for this work was let on Aug. 18 to Nihan, Elliott & Phin, of St. Catharines, Ont. The contract for the portals was let to Wm. Gibson, of Beamsville. The work consists of an open cut 3,100 ft. in length on the Canadian side, and 2,500 ft. in length on the American side. The total amount to be excavated is about 500,000 cu. yds., practically all of which is steam shovel work. Masonry will approximate 20,000 cu. yds., mostly in retaining walls along the sides of the cutting. The tunnel portal is shown in the accompanying drawings.


PORT HURON
Open Cutting
Portal July '89
Aug. Sept. Oct. Nov. Dec. Jan '90 Feb. March Apr. May June July Point of
340.55 Level of Water.
Summit of Rock: 254.55
Aug.
HORIZONTAL SCALE.
0 200 400 600 800 1000 1200 1400 1600 1800 2000 FT.
VERTICAL SCALE.
0 20 40 60 80 100 FT

PROFILE OF THE ST. CLAIR TUNNEL

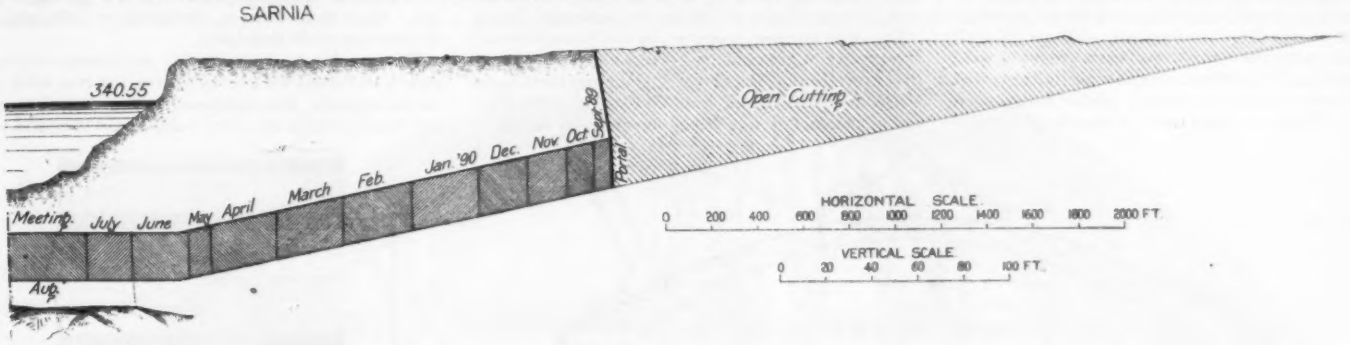


PORTAL FOR ST. CLAIR TUNNEL.—Joseph Hobson, Chief Engineer.

OPERATING THE COMPLETED TUNNEL.

For drawing trains through the tunnel four decapod tank locomotives are being built by the Baldwin Locomotive Works. They are to weigh when in working order 180,000 lbs., all of which is carried on 10 driving wheels. The cylinders are 22 × 28 ins., and the drivers are 49 ins. in diameter. The boilers are 74 ins. diameter, with 280 2¼-in. tubes, 13 ft. 6 ins. long. The fire-box is 11 ft. long and 3½ ft. wide. The wheel-base is 18 ft. 3 ins. The cab is placed midway over the boiler, and the engine can of course be run in either direction. The fuel is to be anthracite or coke, to make as little smoke as possible. The Westinghouse driver brake is on all wheels. The total length of the tunnel and approaches is a little over two miles (11,600 ft.). The estimated capacity

of the tunnel is six trains per hour, each train consisting of about 27 loaded freight cars. Referring to the figures of traffic ferried across the St. Clair river, in our issue of Oct. 4, which averaged in 1888 about 1,000 cars per day, it will be seen that the prsent tunnel can accommodate a traffic about four times as large as that which at present crosses the river. When ready for operation, the tunnel will be lit by the electric lighting plant used in the construction and already described. The ventilation will be furnished by the Root blowers now on the ground. There are two on each side, each with a capacity of 10,000 cu. ft. of air per minute. The 2-ft. air pipe from each end, which was used in the construction, will be extended to terminate near the center of the tunnel. Taking the clear cross-section of the tunnel as 300 sq. ft., we have the total



SHOWING PROGRESS OF THE EXCAVATION.

volume of air in the tunnel as 1,800,000 cu. ft., which could all be passed through the blowers when working to their full capacity in 45 minutes. It is not expected, however, that it will be necessary to keep the blowers running at nearly their full capacity to keep the tunnel reasonably clear of smoke and gas.

The total actual cost of the whole work has not yet been computed, but will approximate very closely to $2,700,000. The subsidy given in aid of the enterprise by the Dominion Government amounts to $375,000. At a later date we hope to publish an itemized statement of the cost. At present the following is a rough estimate of the chief items which make up the cost of the work :

Expended on preliminary work	$250,000
Machinery and plant used in construction	250,000
Labor, all classes	900,000
Cast iron for lining	800,000
Other materials	100,000
Real estate, land damages, legal expenses, etc	110,000
Permanent equipment (tracks, locomotives, etc)	50,000
Approaches	200,000
Engineering, superintendence, etc	40,000
	$2,700,000

The whole responsibility of carrying out the work from inception to completion has rested with Mr. JOSEPH HOBSON, the Chief Engineer. Mr. HOBSON is a member of the Institution of Civil Engineers and of the American and the Canadian Societies of Civil Engineers; and has been connected with the engineering department of the Grand Trunk Ry. since 1870. His assistants in charge of the instrumental work were Messrs. T. E. HILLMAN and M. S. BLAIKLOCK. Mr. J. T. EAMES was the Mechanical Superintendent of the work, and Mr. THOS. MURPHY was Superintendent of Excavation.

The officers of the St. Clair Tunnel Co. are: President, Sir JOSEPH HICKSON; Vice-President, L. J. SEARGEANT; Secretary, ROBERT WRIGHT, Montreal; Directors, JOHN BELL, CHAS. MACKENZIE, Hon. ALEXANDER VIDAL, W. J. SPICER and E. W. MEDDAUGH.

SOME QUESTIONS OF ENGINEERING INTEREST.

To an engineer the completed work presents some novel problems. Cast iron has been used before for tunnel lining to a limited extent, and tunnels have been built before through soft material, but no tunnel, under so great a river, through such soft material and located so near to the river bottom, has ever before been built, and no tunnel of such magnitude has been lined with cast iron.

One question of much interest relates to the buoyancy of the tunnel. The outside diameter of the lining is 21 ft., hence the volume of displacement is 346 cu. ft. per lin. ft. The clay through which the tunnel is driven is of a variable consistency, and in places becomes almost a semi-fluid. Its weight is 125 lbs. per cu. ft. Hence, if we consider the clay to be perfectly fluid, the total buoyancy of the tunnel is 346 × 125 lbs. = 43,250 lbs. per lin. ft. On the other hand, if the clay be considered as a solid, it is to be remembered that it contains water-bearing strata, which, wherever they reach the tunnel, will be pretty certain to work along the smooth iron lining and reach every part of it. Hence, the buoyancy of the tunnel in water alone, or 346 × 62½ lbs., = 21,625 lbs., must be assumed as the minimum buoyancy of the tunnel, which exists at all points, and may be at certain points doubled. The total weight of lining and permanent way can hardly exceed 11,000 lbs. per ft., leaving a remaining maximum buoyancy of 32,250 lbs. per ft., and a remaining minimum buoyancy of 10,625 lbs. per ft. The actual buoyancy lies somewhere between these extremes, and varies evidently with the degree of fluidity of the clay mass.

If the clay in which the tunnel is built were a perfect fluid, the tunnel would rise to the surface. If it were an adamantine solid, the tunnel would be immovably held in place, no matter what its buoyancy. But it is between these extremes. It is probably fluid enough to exert considerable upward pressure on the tunnel, in some places at least. On the other hand, its fluidity causes a downward pressure from the mass of material lying vertically above the tunnel. This is in volume but little more on the average than that of the tunnel itself, and it is probable that a considerable proportion of its weight is borne by the tunnel lining. Whether the material is fluid enough for the upward pressure to equal or exceed the downward is a question which only experiment can settle.

The question is further complicated by the fact that the clay is not of uniform consistency, being in some places quite stiff and hard, and in others very soft, so that, as described above, it flowed back through the bulkhead doors when the shield was forced into it. Nevertheless, even where most fluid, the clay must fall far short of the mobility of a perfect fluid; and if we add to the minimum buoyancy, 10,625 lbs. per ft. (one-third the difference between the maximum and minimum theoretical buoyancies) making 17,833 lbs. per lineal ft., it seems as great an allowance as need be made for the upward pressure the clay.

To prevent this upward force from causing motion, we have first the weight of the clay above the tunnel. The tunnel is 21 ft. in diameter, and the weight of the clay is 125 lbs. per cu. ft. The weight of the clay in water will be 125 lbs. — 62½ lbs. = 62½ lbs. per cu. ft. Hence a layer of clay above the tunnel one foot in depth will weigh 21 × 62½ lbs. = 1,312 lbs. per lineal ft. of the tunnel. Therefore, the thickness of clay required to balance a buoyancy of 17,833 lbs. per lineal ft. will be 17,833 ÷ 1,312 = 13.6 ft. The base of this superincumbent prism is not at the top of the tunnel, but on a line drawn about 2 ft. 8 ins. below the top; hence the depth of clay required above the tunnel to balance an upward buoyancy of 17,833 lbs. is 13.6 ft. — 2 ft. 8 ins. = 11 ft. nearly.

By reference to the accompany profile, or as may be seen more clearly by the profile in our issue of Oct. 4, there are five points in the tunnel where for short distances the clay is less than 11 ft. thick above the tunnel; but at each of these places the added weight of the gravel, sand, and boulders above the clay is more than ample to make up for the thinness of the clay layer. The weight of this material above the clay, the stiffness of the clay mass acting to resist the lifting of the prism of clay lying vertically above the tunnel, and the strength of the tunnel itself acting as a beam to resist a buoyant force on any section, are all resistances of unknown but considerable amount, which operate to prevent upward motion and seem to provide an ample factor of safety against the greatest buoyant force which is likely to be brought to bear.

Of course the above is only an approximation, and depends on assumptions whose accuracy can only be proved by experiment. As regards the relative pressures on the top and bottom of the lining, experiments might easily be made, and it is to be hoped that they may be undertaken.

Another interesting problem relates to the strength of the cast iron lining. The weakest member in this is probably the bolts. Each ring of the lining is joined to the next by 157 steel bolts, ⅞ in. diameter. This gives a sectional area of 94½ sq. ins. joining each two adjacent rings. At 60,000 lbs. ultimate strength this would make the ultimate tensile or shearing strength of the tunnel tube 5,670,060 lbs., or 2,835 tons.

No further calculations are needed to show that as far as strains from the movement of trains inside the tunnel are concerned, the tunnel lining has an enormous margin of strength. As for forces acting from outside the tunnel, if we suppose erosion to remove the gravel and clay from above a section of the tunnel, it will be seen that the lining has strength enough to hold down a considerable section and prevent its buoyancy from breaking it away from the rest.

The only other outer force which seems to demand notice is that of unequal outer pressure. An outer pressure equal on all parts would cause merely a compressive strain on the cast-iron segments. Unequal outer pressure, tending to change the tunnel section from a circle to an ellipse, would tend to break the flanges and bolts of the longitudinal joints. It will be noticed that these flanges are made very thick at the base on purpose to resist forces of this class.

If the material in which the tunnel lies were a perfect fluid, the pressure would be equal in every direction. Actually, the vertical pressures on the tunnel are probably somewhat greater than the horizontal pressures; but that the excess can approach in magnitude the force necessary to break the flanges or bolts of the longitudinal joints seems impossible. The actual pressure, as already stated, can only be determined by experiment, and it is to be hoped that experiments will be made. Not until these pressures are at least approximately ascertained can it be known whether the lining has about a proper margin of safety or is vastly stronger than is necessary.

The success of the St. Clair tunnel has called general attention to the use of shields moved by hydraulic pressure and to the use of cast-iron segments for lining in tunneling through soft materials. Not only for tunnels but for water conduits, sewers and subways it is not unlikely that the precedents established by the work carried out so successfully by Mr. HOBSON will be made use of. But it must be remembered that cast-iron is an expensive lining at best. At St. Clair the cost of the lining was nearly one-third the total amounted expended. To carry out with greatest success, therefore, the new departure in engineering, more exact knowledge is

needed of the forces to be met. Not until this knowledge is available can shields and lining be proportioned with assurance that safety and economy have each had their due allowance.

Improvements to the Passenger Terminals of the Pennsylvania Railroad at Jersey City.

For over four years work has been in progress on improvements of the terminal facilities of the Pennsylvania R. R. at Jersey City. Long delays have occurred in carrying out the work through obstruction by the property owners and the city authorities. Now, however, the work is being rapidly advanced, and seems certain of completion during the coming year. The work comprises the construction of a four-track viaduct about 3,000 ft. in length, replacing the old surface tracks and grade crossings through Jersey City. In our issue of June 25, 1887, the designs for the structure as then proposed were published, and the structure as now partially erected differs little from the deck-plate girder design then shown. There are three rows of heavy columns 18 ins. square, built of plates and angles latticed. The longitudinal girders form spans from 38 ft. 7 ins. to 51 ft. 6½ ins., and have a web 52 ins. × ⅝ in. The web of the cross girders is 57 ins. × ⅝ ins. The whole structure is 44 ft. wide, out to out, and the columns are spaced 18 ft. 3 ins., center to center.

Foundations are of masonry, supported on piles where the ground is bad, as it is for a considerable part of the way. To erect the structure without stopping traffic, two of the surface tracks were moved a short distance to one side so as not to interfere with the foundations for the central row of columns, and all the traffic was turned over to them. All the immense passenger traffic of the Pennsylvania, Lehigh Valley, and New York, Susquehanna & Western railways has to pass over these two tracks, with grade crossings at every street, and is handled in a very crowded yard at the North River terminus. There are 107 regular trains in and 104 out daily; but this does not represent one half the train movements over these tracks, since trains have to be made up at the yard west of the city. It need hardly be said, therefore, that in the busy hours of the day the trains run under very short headway, and the two flagmen at each crossing have a post that is no sinecure, especially since the gates have been removed to facilitate the work of construction. Tracks have been laid on the half of the viaduct now erected, but they cannot be used, of course, until the terminals at the river are in shape to receive passengers.

The viaduct is an especially fine looking structure, partly because of its short spans and deep girders, which give it an appearance of great solidity, and partly because it has been painted a glossy black with Jos. Dixon's graphite paint, which gives a most pleasing effect.

The chief improvement in Jersey City, west of the viaduct, was the straightening of the line at the deep cut through Bergen Hill and the grading of a large yard for car storage. (The change of line was shown by a map in our issue of June 25, 1887). This involved the excavation of about 250,000 cu. yds. of trap rock. The road now enters the city with two 3° curves, between which is a 603 ft. tangent curve, whereas the old line had curves of 6° and 10°, with very short tangents between them. Space has also been obtained here for a 42-stall roundhouse and other buildings for the mechanical department.

The chief interest, however, in the Pennsylvania's Jersey City improvements centers about the North River terminus. The elevated structure terminates at Henderson St., and from here to the end of the tracks the surface has been elevated by filling to a height of 15 to 20 ft. above the former surface. Heavy retaining walls support the embankment on all sides. The total area filled in is about 55,000 sq. yds., requiring 350,000 cu. yds. of earth, about all of which was hauled by construction trains from borrow pits 10 to 20 miles away. At Warren St. and Washington St. the tracks are carried over the streets by bridges.

At the site of the train shed the filling has been so done that the tracks are upon a grade of 0.4%, thus facilitating the starting and stopping of trains. Fig. 1 is a cross-section and elevation of the shed. It will be seen to be an arch-shaped truss, 252 ft. 8 ins. span between pin centers, and 80 ft. high. The ridge of the monitor roof at the top will be 110 ft. above the rail. It will be noticed that the arch has a pin joint at the center, so that the structure is free to expand and contract with changes of temperature. The members above and below the pins are made with sliding joints to permit rise and fall of the structure. The lateral thrust of the arch is taken by a bottom chord which runs underneath the tracks and platforms, as shown in the drawing. The skeleton of the structure will consist of 10 pairs of these trusses, making the total length 600 ft.

The iron work for the train shed as well as for the viaduct above described, is furnished by the Pencoyd Bridge Co., of Pencoyd, Pa.; but the erection is done by the Pennsylvania Railroad Co. Fig. 2 is reproduced from a photograph taken Dec. 19, and shows the traveler which has been built for erecting the iron work of the train shed. It is a huge timber frame 80 ft. high, 230 ft. long, and 60 ft. wide, resting on 12 freight car trucks which run on the permanent station tracks. This traveler is broad enough to support three trusses of the train shed at one time. In erecting the iron work, after each three trusses are put in place and braced, the wedge blocks which support it on the traveler are knocked out and the traveler is moved forward by the winding engine shown near its base, three ropes being attached to alternate trucks to secure an even pull on the different parts.

The traveler contains about 110,000 ft. B. M. of timber and weighs in the neighborhood of 140 tons, or about 12 tons per truck. The added weight of the iron work and the effect of wind pressure in causing unequal bearing on the trucks will probably load them at times nearly to their full capacity. The long vertical posts and braces in the structure are single sticks (not spliced) of Oregon pine, 79 ft. 8 ins. × 12 ins. × 14 ins. These timbers were furnished by Gillingham & Garrison, of Philadelphia.

The traveler as shown in the photograph is completed and ready for use as soon as the iron work is on the ground. The members of the arched truss are none of them of great weight, and they will be

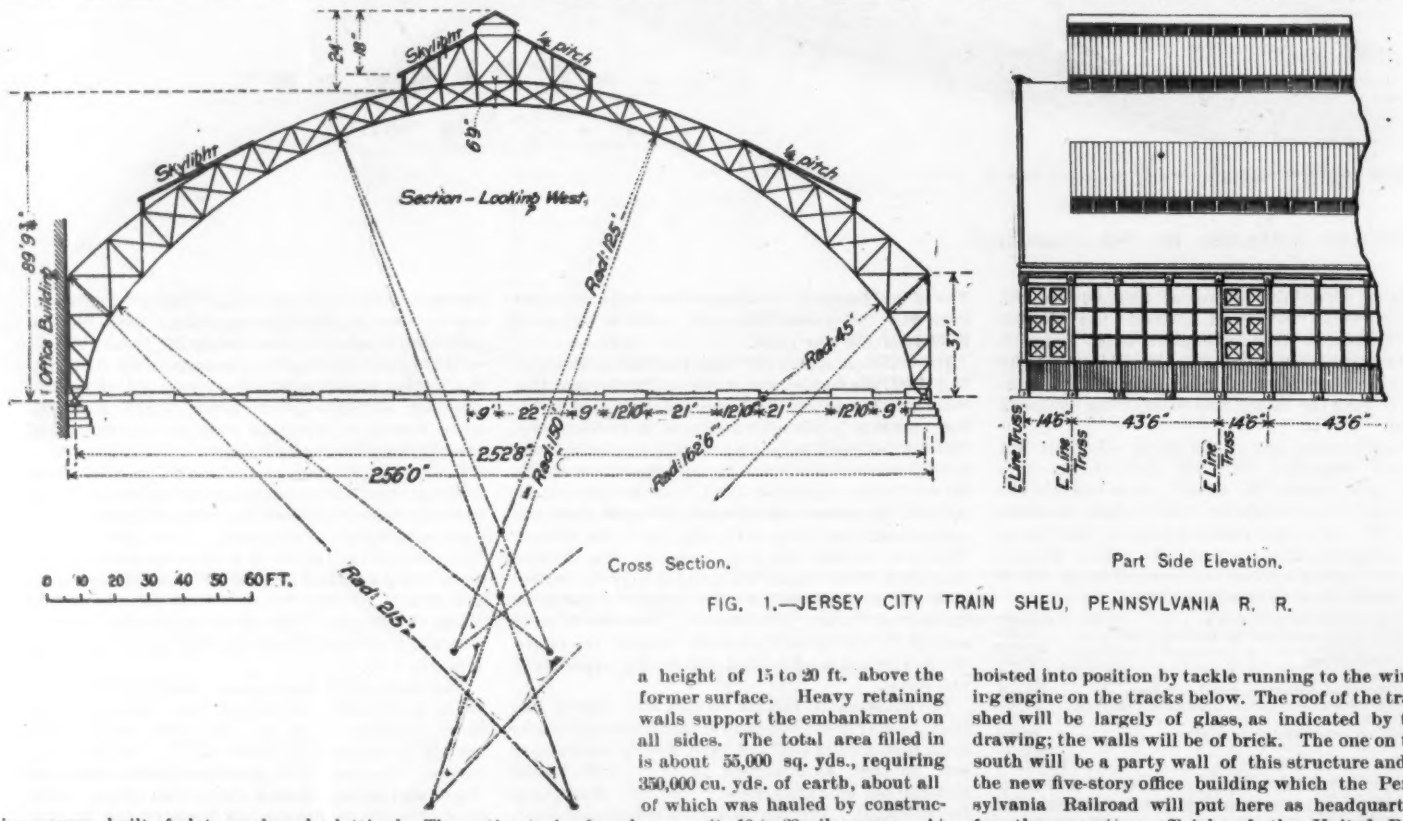


FIG. 1.—JERSEY CITY TRAIN SHED, PENNSYLVANIA R. R.

The designs for the new passenger station, which will stand just east of the train shed, have not been decided upon. It will be so arranged, however, that passengers will pass from the trains through the station and on to the upper deck of the ferryboat. Ferry passengers and teams from Jersey City will pass on to the lower deck of the boat through the ferry house, as at present. At the Cortlandt St. terminus work has begun raising the roofs over the ferry bridges to make room for the two-story bridge which will be required. The station here will also have an added story, and a bridge and elevated sidewalk across West St. and Cortlandt St. as far as the Ninth Ave. Elevated is to be put up. Work has already begun on the foundations for the bridge over West St. It is intended to build a similar bridge and elevated passageway at the Desbrosses St. terminus.

When these improvements are completed the Pennsylvania will be in a far better position to handle suburban traffic from its New York to New Jersey points than ever before; and a large accession to its traffic of this class may confidently be expected.

PERSONALS.

Mr. JAMES B. STEVENSON, Treasurer of the Delaware & Bound Brook, was run over and killed at Fitlers station, on the Pennsylvania R. R., Dec. 18.

Mr. C. A. HENRIQUES has been appointed by Mayor GRANT, of New York, as a trustee of the Brooklyn Bridge, in place of Mr. A. L. MYERS, resigned.

Mr. J. W. ALVORD, for the last year engineer of the town of Cicero, Ill., has received an appointment on the engineer corps of the World's Fair Commission, Chicago, Ill.

Mr. GEO. D. BLAKEY, engineer in charge of the construction of the Pulaski branch of the Norfolk & Western R. R., was killed recently at Sylvester, W. Va., by a stone thrown by a laborer.

Dr. WM. TAYLOR, Secretary and Treasurer of the West Jersey Co., and Treasurer of other roads in New Jersey controlled by the Pennsylvania R. R., died at Cambridge, N. J., Dec. 21, aged 69.

Mr. T. W. M. DRAPER, Chief Engineer and General Manager of the Danville & East Tennessee R. R., has appointed Mr. D. RODGER Assistant Engineer and Mr. E. C. MANNING Assistant General Manager. The office of the latter will be at Bristol, Tenn., and his jurisdiction will extend 100 miles east of that city.

Mr. G. F. H. VON WREDE has been appointed Master Mechanic of the main line division of the Philadelphia & Reading R. R., with headquarters at Philadelphia. Mr VON WREDE is only 24 years old, is a graduate of the gymnasium at Hesse Darmstadt and the Worcester Polytechnic Institute and was for some time in charge of the locomotive testing department on the Pennsylvania R. R.

The following appointments have been made by the Norfolk & Western R. R. Co.: Mr. THEO. LOWE, division engineer, maintenance of way, eastern division, Roanoke, Va.; Mr. G. M. TOMPSON, division engineer, maintenance of way, western division, Roanoke, Va.; Mr. PHILIP WALLIS, division superintendent motive power, eastern division, Roanoke, Va.; Mr. R. P. C. SANDERSON, division superintendent motive power, western division, Roanoke, Va.; Mr. T. H. BRANSFORD, superintendent Roanoke division, Roanoke, Va.; Mr. J. W. COOK, superintendent Shenandoah division, Shenandoah, Va. Mr. Jos. H. SANDS is vice-president, in charge of the transportation department; he will also continue to act as general manager. Mr. DAVID W. FLICKWIR is general superintendent of the eastern division, and Mr. A. C. HIPPEY, general superintendent of the western division; both are located at Roanoke, Va.

NEW PUBLICATIONS.

—*The Civil Engineers' Pocket Book* of Mensuration, Trigonometry, Surveying, Hydraulics, Hydrostatics, etc., etc., by JOHN C. TRAUTWINE, C. E., revised by JOHN C. TRAUTWINE, Jr. New York, John Wiley & Sons. 15th edition, 40th thousand, 12mo, pp. 806. $5.

Little is needed in the way of notice of this latest edition of perhaps the best known engineering work in our language, than to say that the principal change from former editions is a great enlargement of the article on weirs, with a dozen or 20 further additions in various parts of the book to bring it down to the latest date. It is a real service to the profession to have a book of this kind thus frequently and carefully revised, albeit it gives owners of former editions a somewhat uneasy feeling of being behind the times. As a whole, the work has been greatly improved both in form and substance by these changes, which have been intelligently and carefully made. We are pleased to note some better instructions than in former editions in regard to the forms of culvert mouths.

—*Recent Experiments on the Flow of Water over Weirs.* By M. BAZIN, Inspector-General of Bridges and Roads. Translated by ARTHUR MARICHAL and JOHN C. TRAUTWINE, Jr., from *Annales des Ponts et Chaussées*, Oct., 1888. Engineers' Club of Philadelphia, 8vo, pp. 52.

The experiments herein recorded by M. BAZIN are very important and complete, and it is well that they should be made accessible in English by this translation by Messrs. MARICHAL and TRAUTWINE, which appears to have been very carefully made. As we publish elsewhere an abstract of the contents of the paper we will not now notice it further. Every hydraulic engineer should obtain a complete copy of it.

—*The Foreign Commerce of the United States.* Annual Report of the Bureau of Statistics for the year ending June 30, 1890. Pub. Doc., 8vo. pp. 94.

Included in this report, some parts of which we comment upon editorially, are statistics of immigration and our carrying trade, the last of which is rapidly becoming an item which may be described as briefly as the snakes of Ireland.

—*Mineral Resources of the United States*, 1888. 6th Annual Issue, U. S. Geological Survey, J. W. POWELL, Director; DAVID T. DAY, Chief of Division. Pub. Doc., 8vo, pp. 632.

This valuable and elaborate publication is one of the most creditable published by the government as respects completely covering its subject with little superfluous or irrelevant matter. But it appears so late that its statistics are already old, having been published by us in their substance nearly a year ago.

—*The Metric System.* Detailed Information as to Laws, Practice, etc. New York: American Metrological Society, 8vo, pamph., pp. 16.

The nature of the contents of this pamphlet can be imagined from its title. While we sympathize with the purposes of the American Metrological Society, it would have been showing more sense had it given its address on the pamphlet, if not a list of its officers, and we trust the new metric system of numbering pages is not to number them A, B, C, D.

—*Lake Bonneville*, by GROVE KARL GILBERT, U. S. Geol. Survey, Monograph No. 1. Pub. Doc., small 4to, pp. 438. 51 plates, 51 cuts.

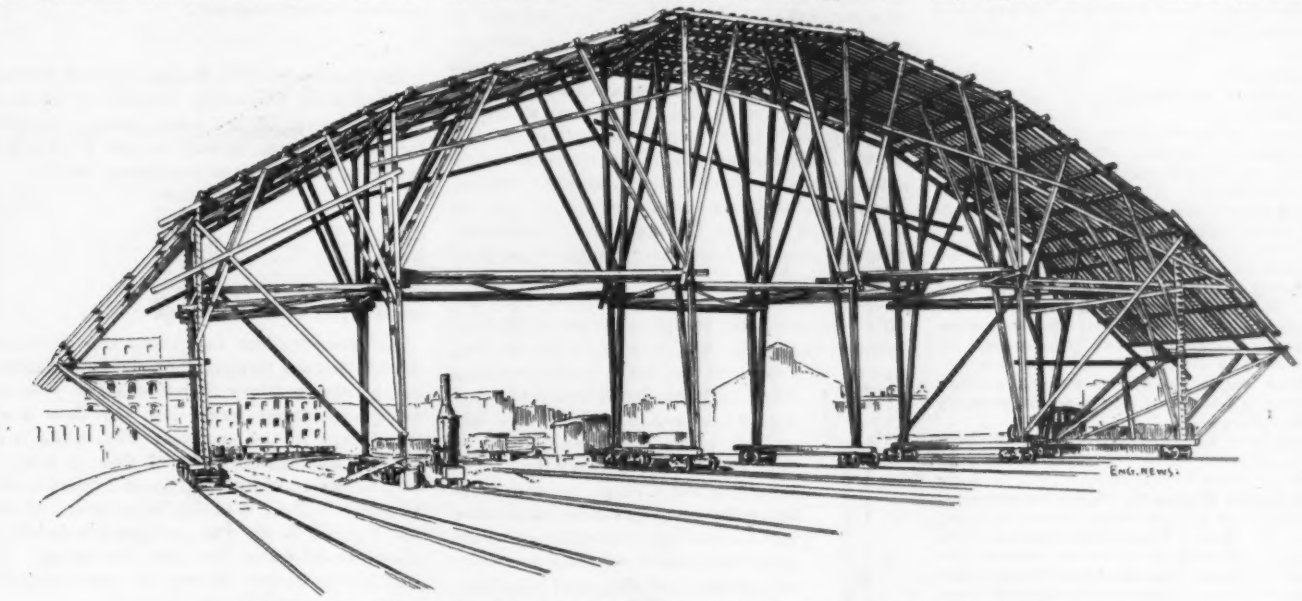
This really magnificent work is a discussion of the geological features of the Great Salt Lake Basin, which formerly held a fresh water lake of many times the extent of the present salt water lake, to which the name of Lake Bonneville has been given. The work is superbly illustrated, and, what is often untrue of such government publications, appears to be worthy of it. Few more interesting geological stories have ever been told, or better told.

—*Bulletins of the United States Geological Survey.* Department of the Interior, Washington, D. C.

No. 58. The glacial boundary in Western Pennsylvania, Ohio, Kentucky, Indiana and Illinois. No. 59. The Jabros and associated rocks in Delaware. Nos. 60 and 64. Reports of work done in the Division of Chemistry and Physics, 1887-88 and 1888-89. No. 61. Contributions to the mineralogy of the Pacific coast. No. 63. A bibliography of paleozoic crustacea, from 1698 to 1889. No. 66. On a group of volcanic rocks from the Tewan mountains, New Mexico, and on the occurrence of primary quartz in certain basalts.

—*Tables of Areas of Right-Angled Triangles of Slopes of ¼ to 1 to 4 to 1.* Being an extract from "Librito del Campo," by JOHN MCGEE, C. E. Buenos Aires. Mackem & McLean. 12mo, pp. 10; 50 cts. For sale by ENGINEERING NEWS.

These very neatly printed and apparently accurate tables give the areas of right-angled triangles for heights varying by 0.1 ft. (or meters) between 0 and 60 ft. in height for slopes of ¼ to 1, ½ to 1, ¾ to 1, 1 to 1, 1¼ to 1, 1½ to 1, 2 to 1, 3 to 1 and 4 to 1. The tables are designed to facilitate the calculation of irregular earthwork, by first computing the section as a series of trapezoids, regardless of the side slopes, and afterward deducting the triangle due to the latter, the height for which, of course, is the height of the slope-stake from grade.



TRAVELLER FOR ERECTING PENNSYLVANIA RAILROAD TRAIN SHED AT JERSEY CITY.

From a Photograph.

TRADE PUBLICATIONS.

—*Consolidated Car-Heating Co.'s Catalogue.*—In our notice of this publication in our issue of Dec. 13 the address of the company was wrongly given as Troy, N. Y. The general office of the company is at Albany, N. Y., and branch offices are located in Chicago, New York City, and Coaticooke, P. Q.

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—At a meeting of the Louisville members of the Society a resolution was adopted endorsing the "St. Louis" nomination for officers of the Society for the ensuing year.

MARSHALL MORRIS, Secretary.

Michigan Engineering Society.—The 12th annual meeting will be held at Lansing on Jan. 20-23, 1891. A list of about twenty papers to be presented at that meeting has been published. The present officers of the Society are: President, J. B. Davis; Vice-President, Geo. L. Wells; Secretary and Treasurer, F. Hodgman.

Montana Society of Civil Engineers.—Meeting of Dec. 20, at Helena. A memorial of the late president, Mr. B. H. Greene, was submitted. Mr. Finlay McRae exhibited the "arithmometer," now used in calculations at the U. S. Surveyor-General Office, and explained its advantages.

The Engineers' Society of Western Pennsylvania at its last meeting nominated the following officers for the coming year: President, Thomas P. Roberts; Vice-President, A. E. Hunt; Secretary, J. H. Harlowe; Treasurer, A. E. Frost; Directors, George S. Davison and T. H. Johnston. At this meeting Mr. J. Eusch read a paper on "Defects in Open-Hearth Furnaces."

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AND

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Geo. H. Frost.....Business Manager

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COMING TECHNICAL MEETINGS.

Iowa Civil Engineers' and Surveyors' Society. Annual meeting, Dec. 30, at Des Moines. Secy., Seth Dean, Glenwood.

Association of Civil Engineers of Dallas.—Next meeting, Jan. 2. Secy., E. K. Smoot.

Engineers' Club of Philadelphia.—Next meeting, Jan. 3. Secy., Howard Murphy, 1122 Girard St.

Civil Engineers' Society of St. Paul.—Next meeting, Jan. 5. Secy., G. L. Wilson.

Denver Society of Civil Engineers.—Next meeting, Jan. 6. Secy., Geo. H. Angell.

Western Society of Engineers.—Next meeting, Jan. 6. Secy., J. W. Weston, 230 La Salle St., Chicago.

Engineers' Club of St. Louis.—Next meeting, Jan. 7. Secy., W. H. Bryan, 30 South 7th St.

American Society of Civil Engineers.—Next meeting, Jan. 7. Secy., John Bogart, 127 E. 23d St., New York.

Engineering Association of the Southwest.—Next meeting, Jan. 8. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

Technical Society of the Pacific Coast.—Next meeting Jan. 9. Secy., O. von Geldern, 408 California St., San Francisco.

Civil Engineers' Club of Cleveland.—Next meeting, Jan. 13. Secy., A. H. Porter, 50 Euclid Ave.

New England Railroad Club.—Next meeting, Jan. 14. Secy., F. M. Curtis.

Civil Engineers' Association of Kansas.—Next meeting, Jan. 14. Secy., J. C. Herring, Wichita, Kan.

Southern and Southwestern Railway Club.—Next meeting Jan. 15, at Atlanta, Ga. Secy., W. H. Marshall, Rookery, Chicago.

New York Railway Club.—Next meeting, Jan. 15. Rooms, Gilsey House. Secy., H. G. Prout.

Engineers' Club of Cincinnati.—Next meeting, Jan. 15. Secy., J. F. Wilson.

Northwest Railroad Club.—Next meeting, Jan. 16. Secy., H. P. Robinson, St. Paul, Minn.

Western Railway Club.—Next meeting, Jan. 20. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery Bldg.

Engineers' Society of Western Pennsylvania.—Next meeting, Jan. 20. Secy., S. M. Wickersham, Pittsburg, Pa.

Boston Society of Civil Engineers.—Next meeting, Jan. 21. Secy., S. E. Tinkham.

Michigan Engineering Society.—Annual convention, Jan. 20 to 23, at Lansing. Secy., F. Hodgman, Climax.

It was discovered too late in binding our issue of last week, that a certain unknown proportion of the portraits of Mr. Wm. P. Shinn, President Am. Soc. C. E., had been somewhat blurred by careless handling in printing. It being impossible to determine after the issue had been mailed to whom these imperfect copies had been sent, we enclose a reprint of this portrait with every copy of this issue, in order that the proper substitution may be made in all copies requiring it.

Readers who have followed our series of articles on the St. Clair Tunnel must have been impressed with the great care with which the details of the work were designed, as was most proper in a work so far outside all precedents in engineering practice. Probably $250,000 would not cover the expense of the plant which was accumulated at the mouth of the tunnel to carry on its construction; and yet when the work of tunneling began, it was found that the rate of progress of the whole enterprise depended simply on the rate at which the clay could be dug away in advance of the shield. All the workmen but the excavating gang, and all the hydraulic machinery, hoisting machinery, etc., were kept idle a good part of the time, or working far below their maximum efficiency, because of the unavoidably slow progress of the excavation.

Because the clay was known to be soft, no difficulty was anticipated in digging it; but in this very softnesss of the clay was the root of the trouble. Had the clay been stiff and dry, it could have been

dug with picks; but it was permeated with water, and in tenacity it is said to have borne some resemblance to india-rubber. An ordinary shovel was soon bent out of shape in prying into the sticky mass, and even spades were soon doubled up. The only tool which would stand the service was a narrow, long-bladed spade imported from England, where it is used in digging ditches for tile drains. The progress made with this implement, however, was discouragingly slow, for the clay had to be pried out in chunks. On the average one gang of 26 men could dig out about enough in 8 hours to advance the shield 2 ft., a creditable enough advance, perhaps, and yet aggravatingly slow, considering that difficulty in digging soft clay was all that held back the whole great work from a progress without precedent in the annals of tunnel-driving.

Before the tunnel had progressed very far, a journeyman cooper in Port Huron, who was "down on his luck," in obtaining work at his trade, secured employment as a laborer in the excavating gang. But he had never been accustomed to work with a shovel or spade; the drawknife was the tool which his hands knew best, and he declared that he could make a tool that would work better than that long-bladed ditcher. The next time he reported for duty he carried an odd shaped drawknife made of a piece of heavy band iron, bent into a half circle, about

6 ins. across, with eyes at each end, in which wooden handles were stuck. The lower side of the band was brought to a cutting edge. With this novel style of drawknife he went to work, despite the jokes of his comrades; and the jokes soon ceased when it was seen that with this little tool a man could stand on the horizontal partitions of the shield and shave the clay down from the working face twice as fast as it could be chopped out with the spades. Those in charge of the work were quick to see the value of the simple invention, and all the men were soon supplied with the new tools. From that time forward the rate of progress of the excavation was materially increased, and the whole work was completed on Aug. 30, 1890, having made the remarkable average rate of progress of 455.4 ft. per month. This is probably a more rapid advance, taking the whole work from beginning to end, than was ever made in any tunnel through any material, and is certainly greater when the large cross-section of the tunnel is taken into account. If the St. Clair tunnel had no other unusual features to make it famous, it would be so because of its rapid construction. That this should have depended upon so insignificant a detail as the form of excavating tool placed in the hands of the laborers, is a fact which carries with it a lesson obvious to every engineer.

The last report of the Bureau of Statistics makes the following interesting exhibit of the simultaneous growth of the total tonnage engaged in foreign commerce entered at our sea ports, and decline of the American percentage thereof:

	Total tonnage.	Per cent. American.
1821-30	9,645,998	88
1831-40	14,226,297	73
1841-50	21,686,091	65
1851-60	43,797,554	67
1861-70	49,098,774	46
1871-80	102,981,110	28
1881-90	135,415,474	22

The one consoling fact about this mortifying table is that our foreign tonnage is both absolutely and relatively larger than it was ten years ago, and was absolutely larger last year than it ever was, except in the one year 1857, when it was 3,485,269 tons against 3,404,584 tons in 1890. In 1881, moreover, our percentage of foreign trade in American bottoms was only 19 per cent., whereas now it is over 22 per cent., a slight gain indeed but enough to show that the tide has turned. If it once begins to run our way it need not take us long to recover all that we have lost.

It is now supposed that the second Board of Experts which is considering the sad case of the Brooklyn Bridge will report early in January. Of the nature of their report nothing whatever has yet become known, unless we may regard as inspired and prophetic some recent declarations of the Brooklyn *Eagle* to the effect that "*Whatever the report of the experts may be* it is regarded as unlikely that the general features of the tail-switching now in vogue will be done away with," coupled with the untrue statement, which has once before been "worked for all it was worth," that "while most desirable with largely increased capacity, the expense of a circulating or loop system renders its adoption simply out of the question." Pending the appearance of the second Board's report, it has not appeared proper that we should have much to say on the merits of the question, but it may be well to quote a prophecy from the report of the first Board of Experts, which was fulfilled last week for the fourth or fifth time since the report was issued:

THE PROPHECY.

It is well known and admitted by all railroad managers that among the many causes which produce derailments by far the most prolific are those resulting in many ways from the use of switches, frogs, and crossings; and notwithstanding the fact that their literal use is an unavoidable necessity in the operation of surface railroads, it is the constant and most solicitous effort of every good railroad operator to reduce their use to the lowest possible minimum on lines of main track, and to place those that cannot be dispensed with in positions the least likely to cause danger, as also to guard them with every possible device to make their use safe and to signal notice to ap approaching trains when they have been moved to positions menacing danger. . . . We are therefore unanimous and most emphatic, in the opinion that under no circumstances should such devices be employed upon the tracks of the Bridge railway. They might of course be employed safely for a long time, but *experience unerr-*

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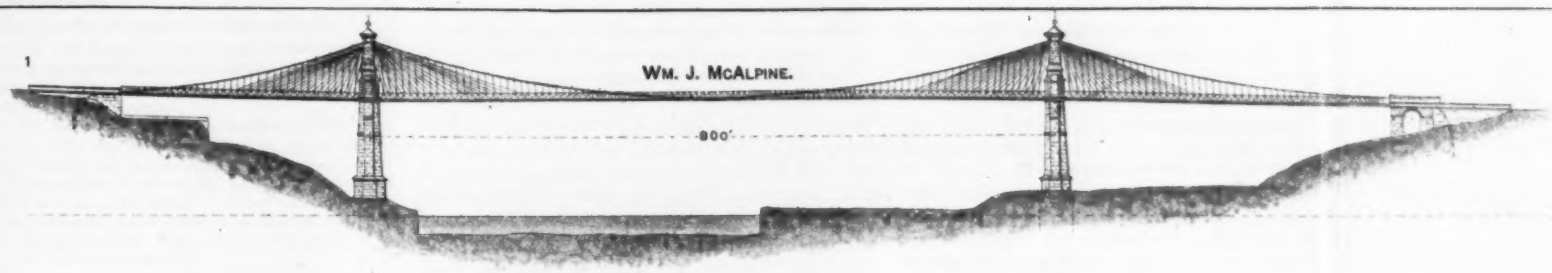

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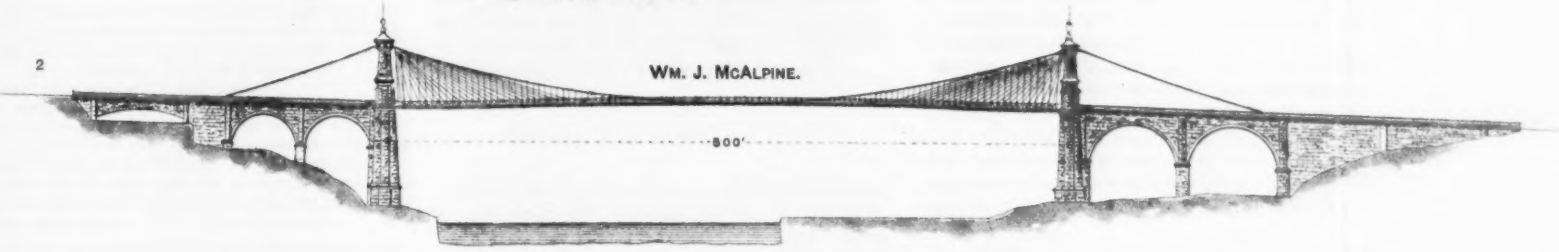

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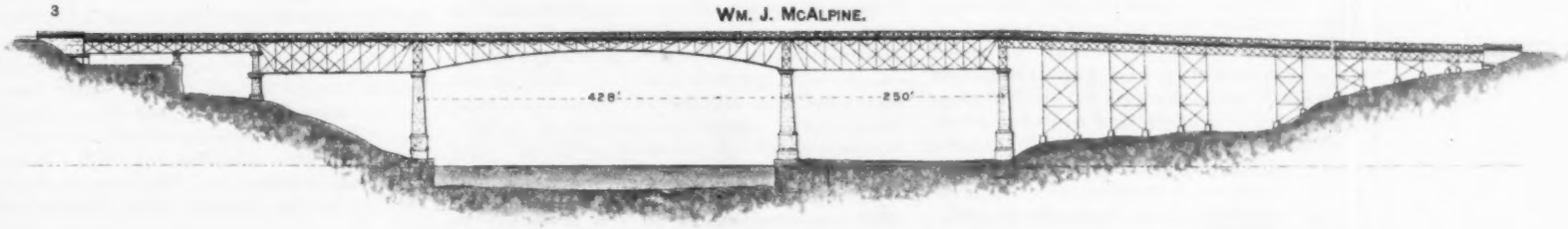

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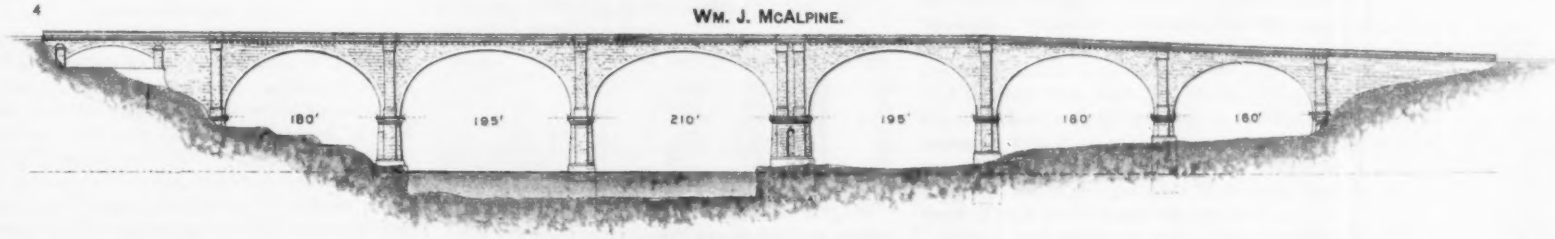

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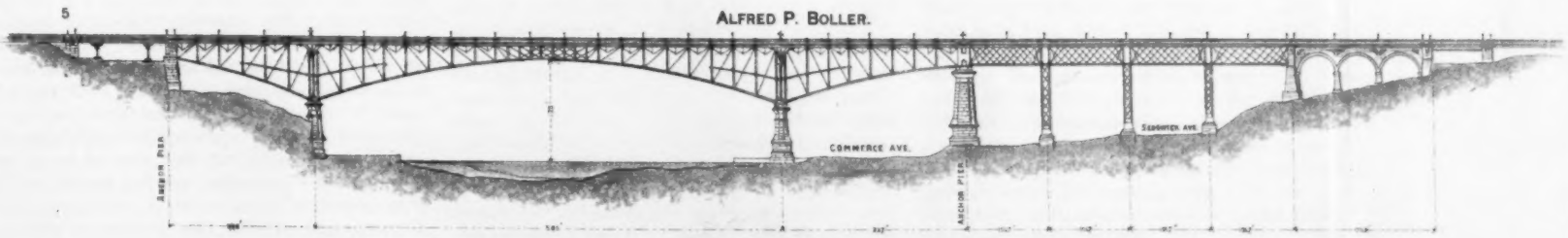

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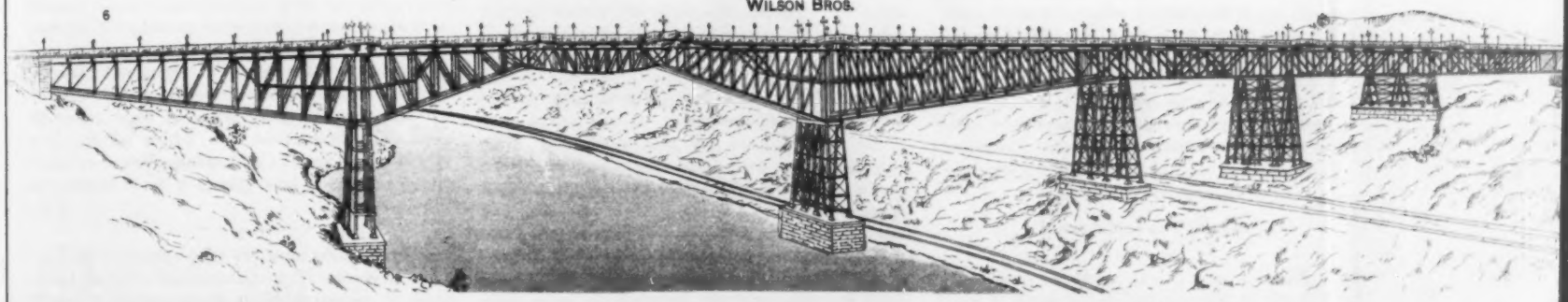

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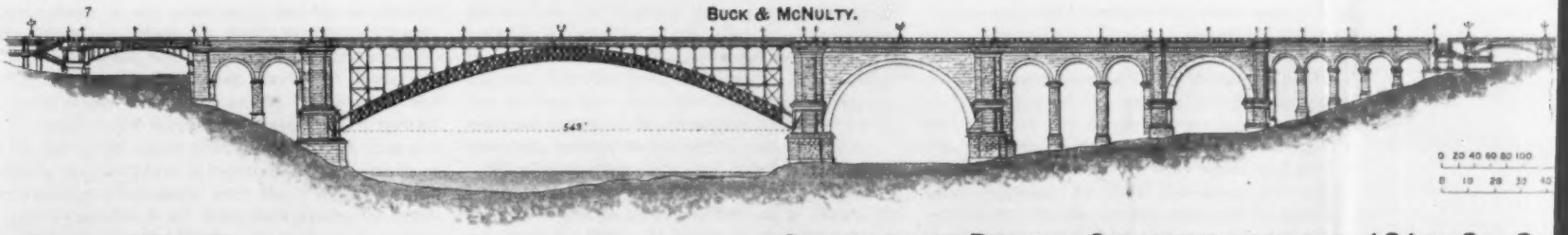

SOME OF THE DESIGNS SUBMITTED FOR THE 181ST ST. CR

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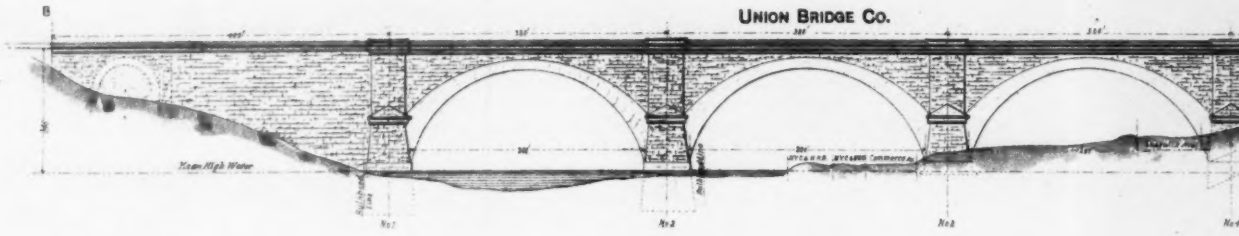
UNION BRIDGE CO.



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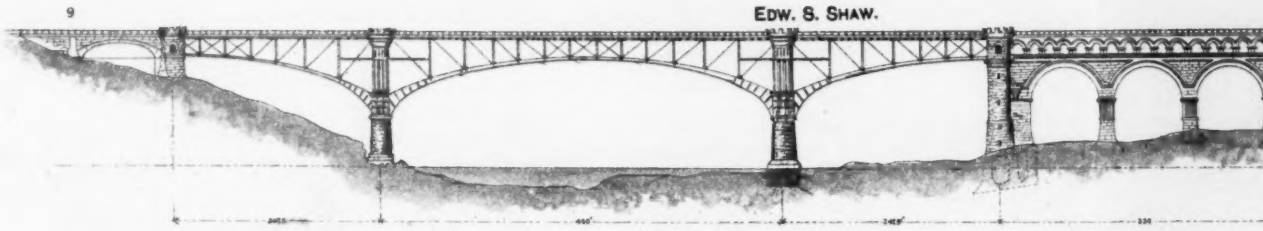
EDW. S. SHAW.



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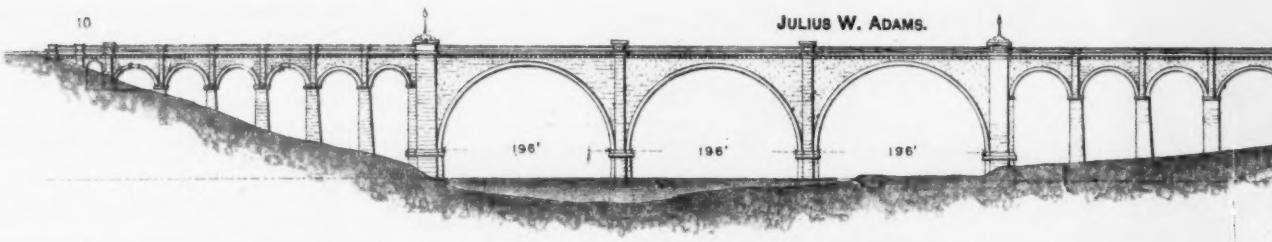
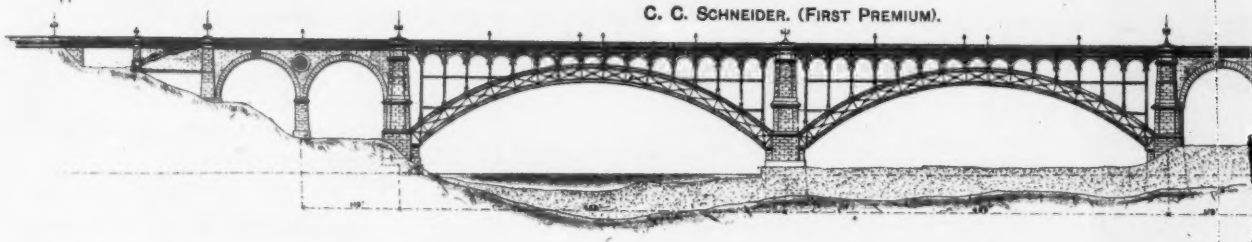
JULIUS W. ADAMS.



11

C. C. SCHNEIDER. (FIRST PREMIUM).



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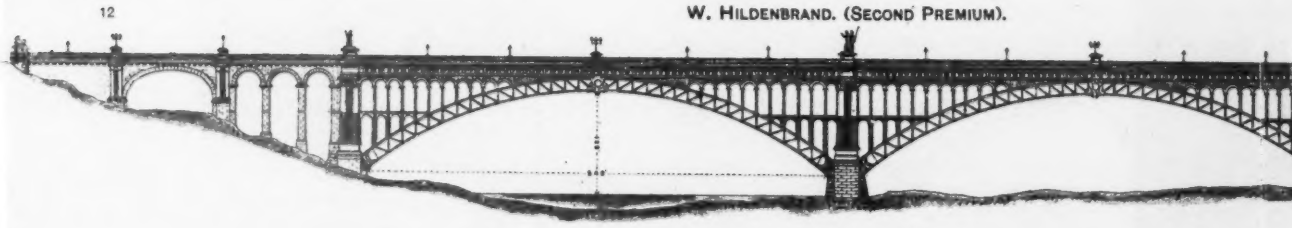
W. HILDENBRAND. (SECOND PREMIUM).



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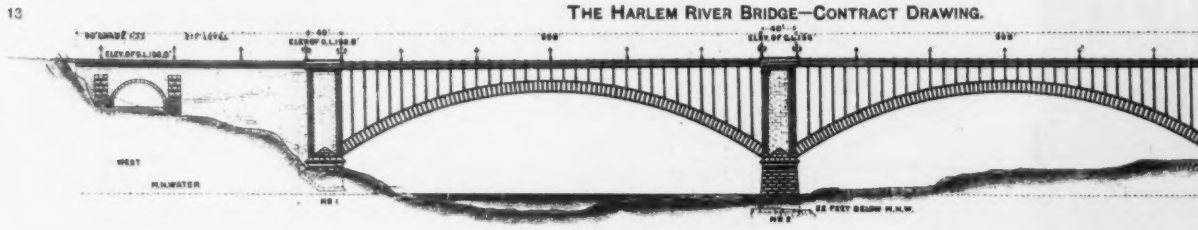
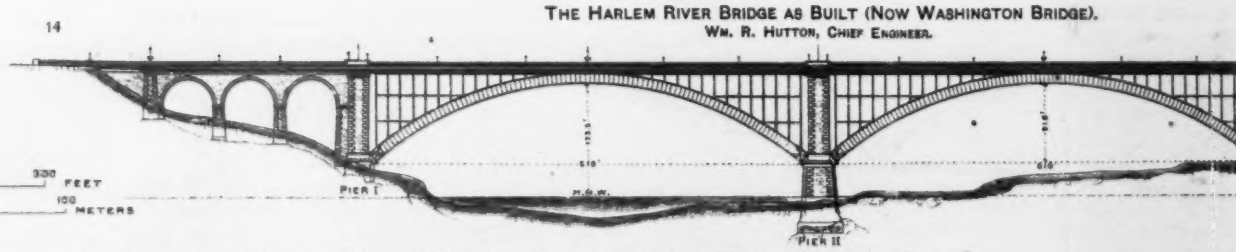
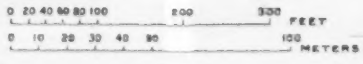
THE HARLEM RIVER BRIDGE—CONTRACT DRAWING.



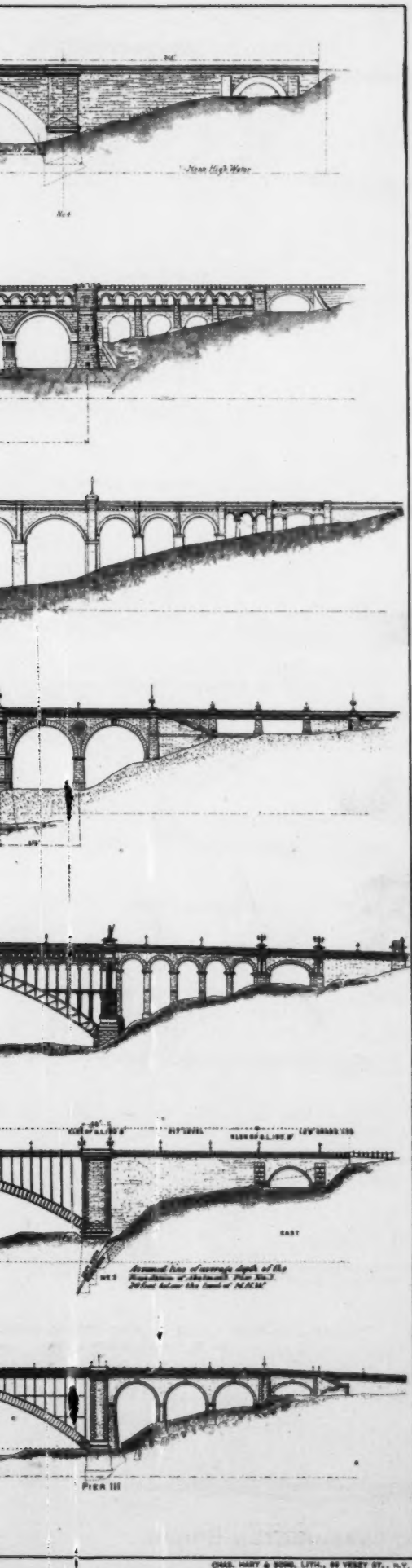
14

THE HARLEM RIVER BRIDGE AS BUILT (NOW WASHINGTON BRIDGE).
WM. R. HUTTON, CHIEF ENGINEER.





181ST ST. CROSSING OF THE HARLEM RIVER, NEW YORK, (WASHINGTON BRIDGE).



CHAS. HART & SONS, LITH., 99 VESEY ST., N.Y.

ingly points to the inevitable accident, which, sooner or later is sure to occur.

THE LATEST OF SEVERAL FULFILLMENTS.

An accident that delayed traffic nearly half an hour and caused great inconvenience to thousands of passengers occurred during the evening rush on the Brooklyn Bridge shortly after 6 P. M. last night.

One of the switch points on the northern track broke down and a car was derailed. It took 29 minutes to repair the damage, and in consequence a crowd of nearly 5,000 people congregated around the entrance, waiting to reach their homes. The rough weather caused many people who ordinarily use the ferries to attempt to reach Brooklyn by the Bridge. This caused the crush to be greater than ever known before.

All the platforms were greatly packed and there was hardly standing room in the avenues leading to them On the upper platforms the crowd extended over on to the Third Avenue Elevated Railroad platform and across the street bridge to the City Hall Park.

Many people, including a number of ladies, took to the footpath, and despite the wind and rain walked across the Bridge. Others hired cabs and were driven over, while a large number left for the ferries. When the damage had been repaired the trains were run as rapidly as possible, but it was two hours before all the delayed passengers had been taken across.—*N. Y. Herald*, Dec. 18.

PANIC, is the great and ever present danger in occurrences of this kind. Panic has so far been escaped, but it may at any moment cause the loss of a score of lives with much less real cause than in this instance. The panic itself cannot be foreseen and guarded against, but the cause of danger from panic can be and should be foreseen and removed instead of being persistently adhered to and defended. When the inevitable slaughter comes, those who for years past have sacrificed the public good to private interest assuredly will not be held guiltless.

THE summary removal of Mr. L. E. COOLEY from his position as Chief Engineer of the Sanitary District of Chicago, is still practically unexplained, and the press of Chicago is divided upon the wisdom and propriety of the action of the Board of Trustees, as might be expected. On sifting down, as well as we can, the evidence coming to us from the Chicago newspapers, it looks as if engineering qualifications had nothing to do with the rupture, and that politics and personal differences between Mr. COOLEY and some of the trustees were the true sources of trouble. The *Inter-Ocean* gives as one item of difference and conflict in ideas, the fact that Mr. COOLEY was planning a ship canal, as he interpreted the law, and that certain of the trustees wanted a mere drainage ditch of about one-half the water area, and that the ditch was preferable to strong railway influences. In any event this long-delayed, much-discussed improvement is still further delayed, and after the experience of Messrs. HERING and COOLEY with the powers that control this sanitary improvement we do not wonder at the refusal of Gen. NEWTON to accept responsible charge. The new chief engineer, Mr. WORTHEN, is an older man than either of his predecessors, both in engineering practice and the ways of the world, and we trust that this riper experience may enable him to steer the enterprise towards at least a speedy and successful beginning.

IN our last issue, page 548, is an article condensed from *Indian Engineering* on "Concreting under Water." In this article *surkhi* is spoken of as an ingredient in the grout used, and the meaning of this term was asked. Mr. BENJAMIN SMITH LYMAN, of Philadelphia, well known as a geologist and mining engineer, and of long service in Japan and India, writes us that this *surkhi* is brickdust, and the word means literally "redness" in Hindustani. As the grout made with this brickdust, lime and sand, in equal parts, is reported in the article as possessing advantages over the Portland cement grout, the note is of more than passing moment, and shows that the Hindus, as well as the Spaniards of Cuba and Mexico, make use of this cheap component of hydraulic mortar. The hydraulic properties of a lime-brickdust compound have long been recognized in this country, by engineers and in engineering text-books, but we have never heard of its actual use to any considerable extent. For ordinary purposes hydraulic cement is too easily accessible and too cheap to warrant experiments with the pulverized brick and lime. But for special purposes, such as the grouting under water mentioned in the article referred to, the fact that it is not so ready to drop the sand component, as is Portland cement, is a feature that could be put to good use by engineers oftener than it is. We have tried grouting up badly laid masonry with Portland cement and sand, one to one, and know that the chief trouble lies in the tendency of the sand to separate and to choke the grouting channels.

Railway Construction of 1890.

In its issue of Dec. 28, 1889, ENGINEERING NEWS, in reviewing the field of railway construction, estimated the probable mileage of track which would be added during the year 1890 as several hundred miles greater than the mileage constructed in 1889. The course of events has now proved the accuracy of this prediction, and we are enabled to present with this issue a summary from our detailed list showing that the new track laid during 1890 will at least equal 5,775 miles, with the possibility that these figures will be slightly increased when the final and corrected statement is made. Summarizing from our detailed list, we give below the mileage of new track laid since Jan. 1, 1890, by groups of States, as compared with that laid in the three preceding years:

Groups.	1887.	1888.	1889.	1890.
New England	126	182	80	92
Middle	215	201	437	328
Central No'n	1,751	897	688	701
So. Atlantic	836	1,174	1,095	1,275
Gulf & Miss. Val.	858	1,022	772	883
Southwestern	5,118	1,500	851	884
Northwestern	3,144	774	506	978
Pacific	691	929	604	631
Total	12,667	6,679	5,095	5,775

These figures include only track laid on extensions of steam railway lines upon which regular trains are to be run to do business as common carriers of both freight and passenger traffic; thus excluding lumber or mining railways not carrying passengers, and city lines, for passenger traffic only. By including such lines the above totals could easily be increased by several hundred miles.

Reserving discussion of the various enterprises in detail until our next issue, when they will be considered in connection with our statistics and map showing the track laid in each year of the last half decade, we shall consider only the main features brought out by the above figures. Adding the above totals, together with the mileage laid in 1886 (8,471 miles), to the total mileage of railway completed Dec. 31. 1885, we have 167,172 miles as the amount of railway completed Jan. 1, 1891. Thus it is seen that, of the total railway mileage of the United States, 36,912 miles, or over 22 per cent., has been constructed during the last five years. A very large proportion of this amount has been built in the 14 States comprised in the Southwestern and Northwestern groups. In fact, considering the competitive nature of the extensions, more construction has been done in those States than was best for either the railways who built the lines or the people who have to support them. The many radical changes in the general currents of traffic, brought about by the construction of these new railways, have been among the principal causes of the disastrous rate wars which have been carried on during the past three years.

Notwithstanding this, the rapidly increasing business has served to attract a large amount of railway capital to those sections, as is shown by our totals for 1890. A change in the character of the lines has, however, been brought about. The new construction of 1889 and 1890 comprises but a small mileage of competitive lines, while in the construction of the two preceding years, competition was the mainspring of action.

The South Atlantic group of States has the greatest amount of new mileage to its credit. This group comprises what are now among the most progressive States of the South, but which for many years suffered their great natural resources to lie undeveloped. The mineral traffic is at present, and will continue to be for some time, the greatest incentive for railway extension in the South. The large systems are rapidly occupying the richest mineral sections, and a large proportion of the new mileage has been built by them either directly, or by companies under their control.

In the New England and Middle groups construction has been less active during 1890 than for several years previous. The work has been confined, with few exceptions, to the construction of short branches by the large companies, and to lines projected to develop local industries. The same is true of the new roads included in the Central Northern group.

Practically the same conditions affect the work in the Gulf and Mississippi Valley States as were spoken of in connection with the South Atlantic States. In the mineral sections, which are being rapidly developed, railway construction has been quite active. On the other hand, this group of States includes a large territory offering but little inducement for the investment of capital in railway construction, and in this section little has been done in the addition of new lines.

The seat of activity in the Pacific Group is confined to the States of Colorado, Washington and Montana. The rush to occupy the rich agricultural and timber lands tributary to Puget Sound has resulted in a large mileage of new track in that section. The State of Washington, indeed, stands at the head in increase of mileage. It is probable that construction will continue to be active in this section for some years. Nearly all of the track laid in this group of States has been the work of four or five large companies.

Taking the work in the United States as a whole, the mileage of new track laid is about 700 miles more than that of 1889, but is less than that laid during any other preceding year of the last half decade. The construction has in nearly all cases been justified by the demands of the traffic and will prove a paying addition to the railway property of the country. As for the future prospects, they are fair for the construction of at least an equal mileage during the coming year, with the possibility that the figures will show a considerable increase over those for 1890.

The most uncertain element in the problem is the present financial stringency which affects new enterprises much more than it does established industries. If the present tight money market continues during a considerable part of the coming season it will put a decided damper on railway extension and reduce very considerably the mileage of the coming year.

Recent Naval Progress.

Less than ten years ago it was generally supposed, at home and in Europe, that if the United States could build the lighter armored class of warships, it would yet have to go abroad for the armament of these ships; and the fact was that our manufacturers then lacked both the plant and experience required for making heavy armor plate and guns of the modern European types. But both deficiencies have been well and rapidly overcome. Our new ships are fully equal, and some of them superior, to their European prototypes; American firms are already equipped to turn out the heavier armor-plate, and now we hear from England that our guns are the best in the world. Lieut.-Col. W. HOPE, V. C., an accepted authority

on ordnance detail, has lately visited this country, and has inspected our gun-making establishments. He is reported as saying that the Bethlehem gun plant is superior to any in the world, and comes the nearest to realizing his dream of a perfect plant of this nature. And he speaks in equally high terms of the Washington gun plant, and says that he was there convinced that it was possible to construct a perfect "built-up" gun, a result due solely to the exceeding excellence of the machine tools and methods used.

This commendation by an English ordnance officer only coincides with the experience already gained by the officers of our own army and navy, who have been carefully studying foreign practice and making experiments of their own meanwhile; and in these experiments they have been backed by the best skill of American manufacturers and mechanical engineers outside of army and navy circles. But it is encouraging to Americans and complimentary to our engineers, civic and military, to realize that it was as late as 1883 that the Gun Foundry Board, appointed to study the American manufacture of guns, reported that the replies from American steel and gun manufacturers were "unsatisfactory" because "the subject was a new one to those addressed." The Board at that date concluded that none of the desired information could be obtained from our manufacturers, "because of their lack of experience." The manufacturers themselves declared that they did not possess apparatus capable of forging the large ingots required for modern guns, nor the tools to rough bore and turn them, nor the appliances for tempering material of the weight and sizes demanded by the Government.

While it is true that we taught the world how to build and fight ironclad ships and heavy guns, in our war of 1860-65, it is also true that for over 20 years we have been practically without a navy that would do credit to a fourth-rate power, and our wealthiest cities have been defenceless against the possible attack of any insignificant power that had the money or credit to supply itself with the modern appliances of war. This reproach is in a fair way of being removed from us; and few will deny that the portion of our surplus wealth spent in making a new and creditable navy and in building guns that rank with the best that Europe can furnish, was the wisest national expenditure made in our generation. We do not need either for war, and trust our guns may never be turned against any civilized power. But an equipment of this character, equal to or surpassing the best of other nations, is the best insurance we can have against war, and our rank among nations demands such an equipment. We have been wise, perhaps, in waiting while others made their costly experiments and failures; but we can not afford to wait forever, and the late results, in ships and guns, show that our Government has been closely watching these experiments and is now ready to profit by them.

CORRESPONDENCE.

Cement and Salt Water.

NEW YORK, Dec. 20, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Your article on cement and salt water is valuable. I have frequently known good cement mortar to become worthless by too rapid drying, and was long ago convinced that the use of salt water was a benefit in one way at least.

The theory of cement setting ascribes that action to crystallization which requires water, hence the absence of water will prevent setting, so that too rapid drying is fatal. I have known a quantity of dried salt kept in a pasteboard box to absorb so much water from the air as to convert the pasteboard to a wet, soft pulp, and I believe the presence of salt in mortar, by absorbing moisture or more properly by holding the water already obtained, will prevent rapid drying and permit the cement to fully crystalize.

CHAS. J. BATES.

The Consolidated Car-Heating Co.—Correction.

ALBANY, N. Y., Dec. 20, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR:—I send you two addresses to-day received by us, by which you will perceive that your paper has some circulation, and that a misstatement of our place of business contained in your recent issue, which gives it as Troy, instead of Albany, N. Y., is causing us some annoyance. We hope you will take the trouble to make it clear that our main offices are *at Albany*, with branches at New York, Chicago and Coaticook, Canada.

WM. G. RICE,
Vice-President and Treasurer.

[The mischance happened merely by a slip of the pen of an editor in an absent-minded moment, and we trust deceived but few, who were not already familiar with the name and home of this now important company.—ED. ENG. NEWS.]

The Kaw River Bridge Details.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In ENGINEERING NEWS of Nov. 29 there are sketches of the Kaw River Bridge at Kansas City that show how much the details of a bridge contribute to its safety. Probably all engineers familiar with this particular subject, on examining these sketches, concluded that the fiber of the iron in the plate that failed ran parallel to the direction of the beam. It also appears from these sketches that there were no stiffeners on the beams near the suspenders, and if there were the result shows how little they were worth. Here was an otherwise fairly good structure nearly ruined for the want of a little more care in designing the details, or by the desire to save a few cents' worth of labor in the shops. Had stiffeners of the proper size been used here, and put on as they ought to have been, an accident of this kind probably could not occur. When stiffeners are used oftentimes too little attention is paid to the way in which they are put on. In all cases where they are used under a concentrated load they should be fitted tightly against the projecting flanges by grinding or chipping, and at floor beam suspenders the projecting leg of the angle should extend out the full width of the angle of the beam. The writer has repeatedly seen the projecting leg of the angle cut off at an angle of about 45°, and at the ends of plate girders these stiffeners would not come within ¼ in. or more of the flange resting on the bearing plates, and in many cases this was the work of the best companies in the country; all of which only emphasizes the fact that the details need more careful watching. With good details the lightest structure may do service for an indefinite time and be fairly safe, but with poor details the heaviest and presumably the most substantial structure only becomes a death trap.

Passenger Station at Bay City, Michigan Central Railroad.

In our issue of Sept. 27 reference was made to the fine new passenger station then nearly completed at Bay City, Mich., for the Michigan Central R. R. The engravings herewith presented are from photographs of the station, which was opened to the public in September. This station seems an even handsomer piece of architecture than either of the three fine stations on the Michigan Central illustrated in ENGINEERING NEWS of Sept. 10, 1887. The Bay City station is built of a brown sandstone with a reddish tinge. The stone seems, in fact, of rather too light a hue for a railway station, where the exposure to smoke and soot is likely to be considerable; and a darker stone would give a richer effect even while the building is new. The tower is the feature of the building of chief architectural importance, and it saves the long low stretch of roofs and gables from the shed-like appearance it would otherwise have. The treatment of the tower is excellent, and the clock dials give it a useful office to perform and redeem it from being mere ornamentation.

The general arrangement of the first story is shown on the accompanying plan. The south end of the building is devoted to a well-lighted dining room, 65 × 25 ft., with kitchen, serving room, store rooms, etc. In the second story are four sleeping rooms. The small building, connected by a shed roof to the larger, contains the men's water closet, baggage room, express room and boiler room. The men's waiting room is finished in red oak. The remainder of the inside finish is of birch, which costs about the same as red oak, and is a handsomer wood. The women's waiting room has an open wood fireplace, similar in design to that in the station at Battle Creek (ENG. NEWS, Sept. 10, 1887). The *porte cochere* is still not a common addition to a railway station, but it is of evident utility and adds much to the architectural effect. The second story of the main building with a few rooms in the third story is devoted to offices for the Division Superintendent and other general officers having headquarters here, with rooms also for conductors.

The chief criticism to be made upon the station is that no protection is afforded the passengers in going from the train to the station in inclement weather. The nearest track is, as the writer remembers, about 20 ft. from the front of the building. A wooden platform on a level with the rails extends over this area and looks not at all in keeping with the well built stone station. Besides the sloppy discomfort of getting on or off trains here in a pouring

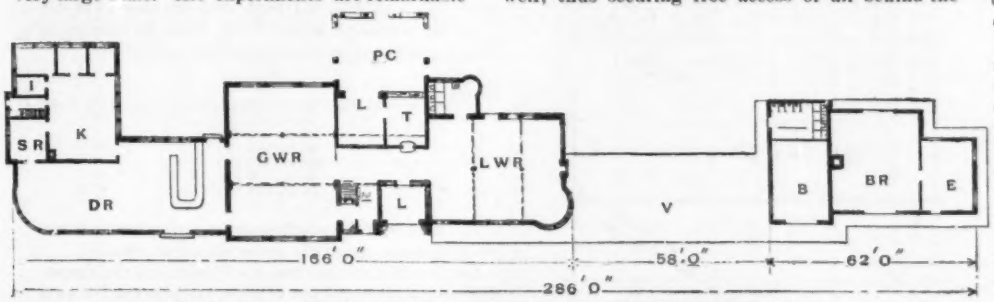
BAY CITY PASSENGER STATION, MICHIGAN CENTRAL RAILROAD, FRONT VIEW.

rain, the platform is bound to decay very rapidly and require frequent repairs and renewals. No doubt it is difficult to obtain good architectural effects when a long stretch of roof is added to cover platforms, and time will show whether travelers at Bay City will stand an occasional wetting for the sake of having their æsthetic tastes gratified.

Bazin's Experiments with Weirs.*

To the classic weir experiments of Francis, at Lowell in 1852 and 1883, and of Fteley and Stearns, at Boston in 1877-9, must now be added those of Bazin, at Dijon, France, in 1886-8.

Like his predecessors, M. BAZIN operated upon a very large scale. His experiments are remarkable for the length and regularity of the channel of approach and for the wide range of variation in the height of the weir and the head above it. These features combined to give high and widely varying values of the coefficient, as will appear as we proceed.



PLAN OF ROUND FLOOR OF BAY CITY PASSENGER STATION.

G W R.	Gentlemen's waiting room.	B R.	Baggage room.	S R.	Sewing room
L W R.	Ladies waiting room	E.	Express room.	I.	Ice.
V.	Veranda.	D R.	Dining room.	T.	Ticket office.
B.	Boiler room.	K.	Kitchen.	L L.	Lobby.
		P C.	Port Cochere.		

Perhaps the most striking feature of these gaugings is the marked effect of the velocity of approach (which was regulated by modifying the height of weir), as shown by the wide divergence of the curves in the diagram herewith. It may indeed appear questionable whether the length and regularity of the channel has not given to the velocity of approach an exaggerated importance in these experiments, out of proportion to that which it possesses in ordinary cases.

The gaugings about to be described, were made exclusively with *suppressed* weirs (*i. e.*, weirs extending entirely across the width of the channel of approach, and thus without lateral contraction), discharging freely into the air.

The water used was taken from the Canal de Bourgogne, through sluices, into a masonry chamber 15 m. (49.21 ft.) long by 4 m. (13.12 ft.) wide, in which it came to rest, and which communicated freely with a second chamber, or channel of approach, of the same length but of only half the width. At the lower end of this was placed the "standard weir" (*deversoir* type), over which the water passed into the channel proper, 200 m. (656 ft.) 2 m. (6.56 ft.) wide, and 1.2 m. (3.94 ft.) deep. This rectangular channel, the bottom of which sloped about 1 in 1,000, was, like the shorter one immediately above it, smoothly lined with a thin concrete of Portland cement. At intervals along the sides of the channel vertical grooves were provided in order to hold stop-planks for sustaining the weirs to be placed at such points, while about 16 ft. above each of these grooves and close to the channel a pit was dug, about 20 ins. square and as deep as the channel. These pits, or lateral chambers, communicated with the channel through circular openings 4 ins. in diameter made in the side wall of the channel and close to its bottom, and were used for ascertaining approximately the levels in the channel at those points, the water surface in them being much less agitated than that in the channel itself. The levels, for this purpose, were measured by means of a "dial-float" (*flotteur a cadran*), consisting of a zinc float communicating by a cord with an axle carrying the hand of a dial, which was read at frequent intervals.

For the exact determination of the levels in the vicinity of each weir, three cast-iron blocks were built into the masonry, one in the side wall of the channel immediately over each end of the weir, and one in the lateral chamber, 16 ft. above the weirs These three blocks were then filed down so as to bring them all to precisely the same level. In connection with them the hook-gauge was used, and also a slide-rule provided with a point at its lower extremity. The latter instrument was used for ascertaining not only the elevation of the water surface, but also that of the crest of the weir.

The formation of a vacuum behind the falling-sheet of water was prevented by widening the channel on each side and immediately below each weir, thus securing free access of air behind the sheet; and the latter was prevented from expanding into these air chambers by projecting boards which prolonged the sides of the up-stream channel (above the level of the crest) to a short distance beyond the falling sheet, which they thus served to guide.

The weirs were built up of horizontal timbers 4 in. square and perfectly water-tight; and the crest was formed by a carefully-straightened iron pate plate or "thin partition," 7 mm. (0.276 in.) thick, fixed to the topmost timber so as to form an upward prolongation of the back of the weir. The fluid sheet touched only the upper and inner corner of this thin plate.

The experiments divide naturally into two distinct sets of operations: (1) gauging the upper or standard weir, and (2) comparative experiments upon weirs of different heights, but otherwise similar.

I.—GAUGING THE UPPER OR STANDARD WEIR.

The standard weir, as already observed, was placed at the upper end of the channel 200 m. (656 ft.) long, in which all the experiments were made; and, in order to eliminate as far as possible the effect of the velocity of approach, it was given the greatest available height, 1.135 m. (3.72 ft.)* above the bottom of the channel.

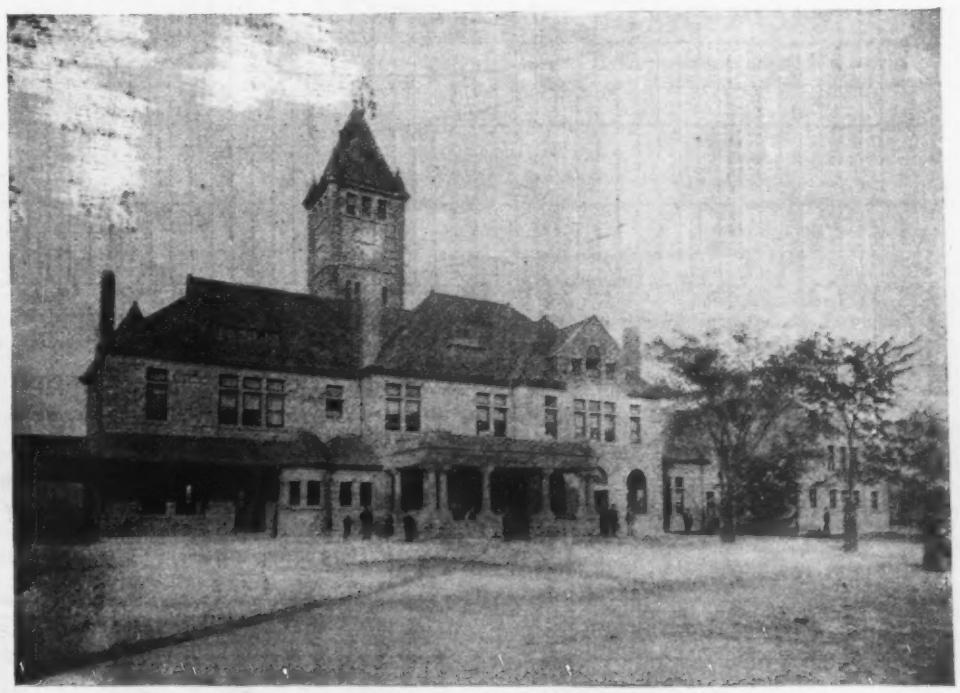
The volume Q of water discharged over this standard weir during a given time was retained and measured in the long rectangular channel into which it fell; and the gauging consisted in determining, for each head, the value of the coefficient M in the formula,

$$Q = L\,M\,H\,\sqrt{2\,g\,H}$$

in which Q = the discharge per second, L = the length of the weir, H = the head of the weir, or the difference of level between the crest and the surface of the up-stream water.

Before commencing the operation of gauging, sufficient water was admitted to the measuring channel to cover its bottom completely from end to end. The level of this surface was carefully ascertained; and, at the end of the experiment the level was again observed. The difference between these two elevations was plainly the depth of the parallelopiped of water admitted; and, the width of the channel having been measured at intervals of 5 m. and at different heights, the volume Q that had passed over the weir during the experiment was readily computed.

For the gauging of the standard weir three series of experiments were carried out (see the curve for points marked 1, 2 and 3 in the diagram). Series 1 was made with a weir 2 m. (6.56 ft.) long, extending therefore across the entire width of the channel, and with heads from 0.059 m. (0.19 ft.) up to 0.3085 m. (1.02 ft.); but it was found that with greater heads than this flowing over so long a weir the channel below filled up too rapidly. The width of the channel of approach was therefore reduced, by a longitudinal wooden partition, to 1



BAY CITY PASSENGER STATION, REAR VIEW.

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The volume Q of water discharged over this standard weir during a given time was retained and measured in the long rectangular channel into which it fell; and the gauging consisted in determining, for each head, the value of the coefficient M in the formula,

$$Q = L\,M\,H\,\sqrt{2\,g\,H}$$

in which Q = the discharge per second, L = the length of the weir, H = the head of the weir, or the difference of level between the crest and the surface of the up-stream water.

Before commencing the operation of gauging, sufficient water was admitted to the measuring channel to cover its bottom completely from end to end. The level of this surface was carefully ascertained; and, at the end of the experiment the level was again observed. The difference between these two elevations was plainly the depth of the parallelopiped of water admitted; and, the width of the channel having been measured at intervals of 5 m. and at different heights, the volume Q that had passed over the weir during the experiment was readily computed.

For the gauging of the standard weir three series of experiments were carried out (see the curve for points marked 1, 2 and 3 in the diagram). Series 1 was made with a weir 2 m. (6.56 ft.) long, extending therefore across the entire width of the channel, and with heads from 0.059 m. (0.19 ft.) up to 0.3085 m. (1.02 ft.); but it was found that with greater heads than this flowing over so long a weir the channel below filled up too rapidly. The width of the channel of approach was therefore reduced, by a longitudinal wooden partition, to 1 m. (3.28 ft.) for the second series of experiments; and, with the weir thus reduced in length, gaugings were conducted under heads from 0.0572 m. (0.188 ft.) up to 0.408 m. (1.34 ft.). But it was desired to extend the investigation to still greater heads, and as the level of the water in the Canal de Bourgogne was not high enough to permit a further increase of the depth in the channel of approach, the desired increase of head was obtained by lowering the crest of the weir 0.13 m., making it 1.005 m. (39¾ in.) high; and its length was at the same time still further reduced, by a wooden partition as before, to 0.50 m (19¾ ins.). With this arrangement the gaugings of

* Condensed from Expériences Nouvelles sur l'Ecoulement en Déversoir (Recent Experiments on the Flow of Water over Weirs), by M. Bazin, Inspecteur General des Ponts et Chaussées. From Annales des Ponts et Chaussées, October, 1888. Translated by A. Marichal and John C. Trautwine, Jr., for the Proceedings of the Engineers' Club of Philadelphia.

* Mr. FRANCIS' highest weir was 5 ft., and Messrs. FTELEY and STEARNS' 6 ft. 6¼ ins. high.

Series 3 were made, with heads running up to 0.54 m. (21¼ ins.).

The three series gave values of M as shown in Table 1:

TABLE 1.

VALUES OF M, OR COEFFICIENT FOR STANDARD WEIR, IN THE FORMULA $Q = M\,L\,H\sqrt{2\,g\,H}$; DEDUCED FROM

Series 1, Weir 1.135 meter high, 2 meters long.
" 2, " 1.135 " 1 "
" 3, " 1.005 " 0.5 "

Heads, H.	Mean values of M.			Number of experiments in each group.		
Meters.	Series 1	Series 2	Series 3	Series 1	Series 2	Series 3
0.05 to 0.07	0.4418	0.4435	0.4472	2	2	1
0.07 to 0.11	0.4338	0.4323	0.4370	9	4	3
0.11 to 0.15	0.4314	0.4288	0.4311	12	3	5
0.15 to 0.19	0.4272	0.4248	0.4276	16	5	4
0.19 to 0.23	0.4263	0.4261	0.4252	10	4	2
0.23 to 0.27	0.4254	0.4259	0.4249	10	6	5
0.27 to 0.31	0.4270	0.4271	0.4269	8	4	5
0.31 to 0.35	.....	0.4273	0.4259	..	4	3
0.35 to 0.39	.....	0.4279	0.4283	..	4	4
0.39 to 0.43	.....	0.4280	0.4295	..	2	3
0.43 to 0.47	.....	.....	0.4319	..	..	3
0.47 to 0.51	.....	.....	0.4325	..	..	7
0.51 to 0.55	.....	.....	0.4332	..	..	3

Owing to the reduction of the height of the weir in series 3, and the consequent slight increase in the velocity of approach, its values of M ought to be somewhat greater than those of the other series; whereas in the middle portion of series 3 (heads from 0.19 to 0.35 m.), they are, on the contrary, a little smaller. But for several reasons the results of series 3 are regarded as less reliable than those of the other two, and M. BAZIN has, therefore, used them only for the purpose of deducing the law of the increase of M for heads greater than about 0.40 m., beyond which the other two series did not go. See diagram.

M. BAZIN now proceeds to compare the foregoing results with those obtained by Messrs. FTELEY and STEARNS under similar range of head, first applying to the latter a small correction (deduced from his own experiments with lower weirs, described further on) for the difference in height between their weirs and his own, with the result shown in Table 2:

It will be noticed that the differences between Messrs. FTELEY and STEARNS' and M. BAZIN's coefficients decrease regularly as the heads increase. They are no doubt due, in part at least, to the difference in the length of the channel of approach, which in the French experiments was 49 ft., while in those of Messrs. FTELEY and STEARNS it was but 12 ft.

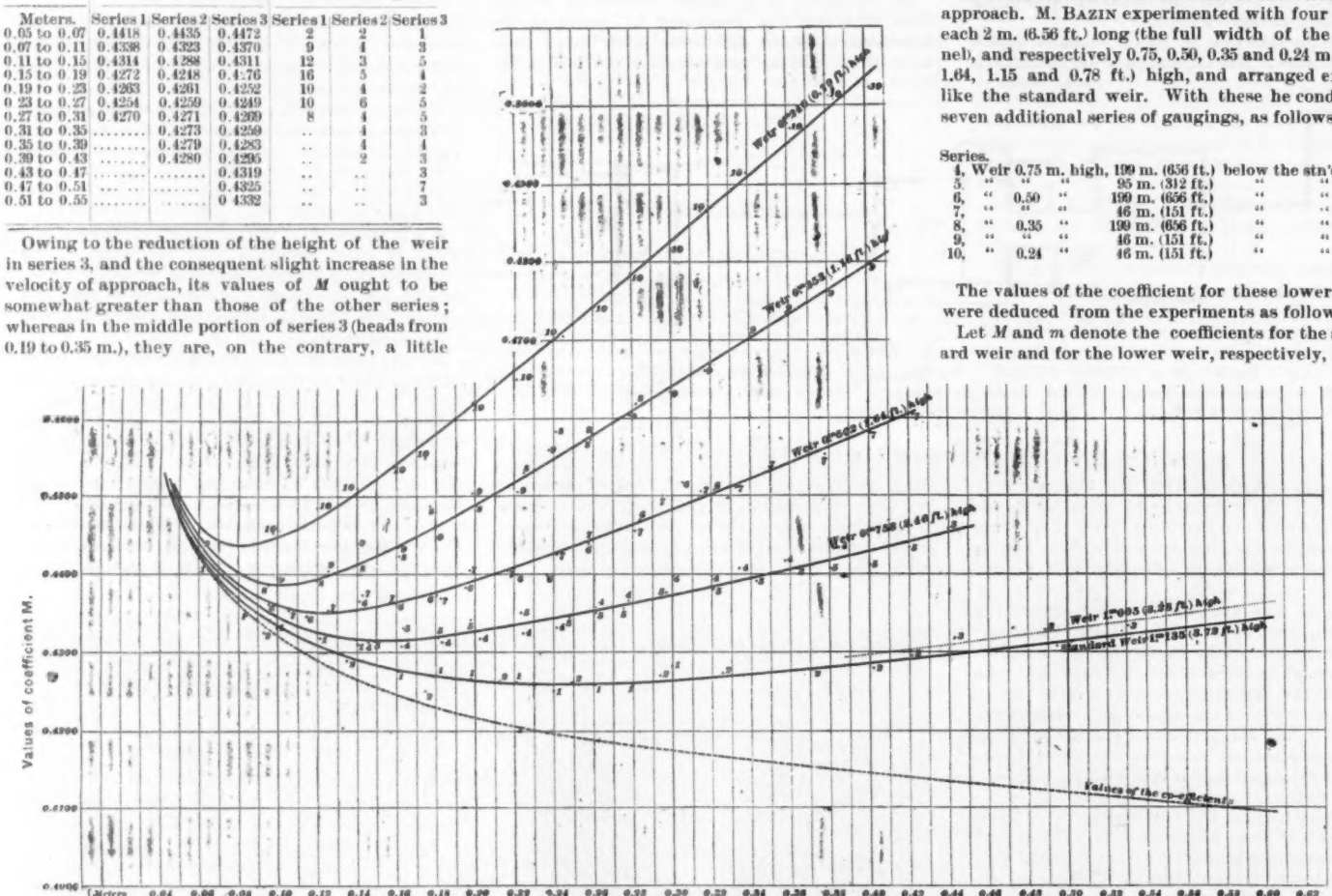
II. COMPARATIVE EXPERIMENTS WITH WEIRS OF DIFFERENT HEIGHTS.

In order to ascertain the effect of the velocity of approach. M. BAZIN experimented with four weirs, each 2 m. (6.56 ft.) long (the full width of the channel), and respectively 0.75, 0.50, 0.35 and 0.24 m. (2.46, 1.64, 1.15 and 0.78 ft.) high, and arranged exactly like the standard weir. With these he conducted seven additional series of gaugings, as follows:

Series.
4, Weir 0.75 m. high, 199 m. (656 ft.) below the stn'd weir.
5 " " " 95 m. (312 ft.) " " "
6, " 0.50 " 199 m. (656 ft.) " " "
7, " " " 46 m. (151 ft.) " " "
8, " 0.35 " 199 m. (656 ft.) " " "
9, " " " 46 m. (151 ft.) " " "
10, " 0.24 " 46 m. (151 ft.) " " "

The values of the coefficient for these lower weirs were deduced from the experiments as follows:

Let M and m denote the coefficients for the standard weir and for the lower weir, respectively, L and



CURVES SHOWING VALUES OF THE COEFFICIENT M.

The experiments of each series are represented by points bearing the number of the series.

TABLE 2.

VALUES OF M (OR COEFFICIENT FOR THE STANDARD WEIR) DEDUCED FROM FTELEY AND STEARNS' RESULTS.

And compared with those obtained by M. BAZIN, as given by the curve for Series 1. 2 and 3.

Heads.	Values of coefficient M.		Differences.
	Fteley and Stearns, corrected for weir 1.135 meter high.	M. Bazin, standard weir, 1.135 meter high.	
Meters.	Experiments of 1877.		
0.0772	0.4223	0.4379	0.0156
0.0949	0.4209	0.4344	0.0135
0.1038	0.4208	0.4331	0.0123
0.1186	0.4198	0.4312	0.0114
0.1393	0.4186	0.4291	0.0105
0.1451	0.4202	0.4288	0.0086
0.1586	0.4202	0.4279	0.0077
0.2053	0.4206	0.4261	0.0055
0.2487	0.4238	0.4259	0.0021
	Experiments of 1879.		
0.1428	0.4149	0.4290	0·0141
0.1969	0.4166	0.4263	0.0097
0.2497	0.4191	0.4259	0.0068
0.3008	0.4218	0.4266	0.0048
0.3530	0.4247	0.4276	0.0029
0.3957	0.4272	0.4285	0.0013
0.4434	0.4296	0.4295	0.0003
0.4888	0.4323	0.4310	—0.0013

TABLE 3.

MEAN VALUES OF THE COEFFICIENT M. FOR THE FOUR LOWER WEIRS.

HEADS h.	Weir 0.75 Meter High.				Weir 0.50 Meter High.				Weir 0.35 Meter High.				Weir 0.24 Meter High.	
	Series No. 4.		Series No. 5.		Series No. 6.		Series No. 7.		Series No. 8.		Series No. 9.		Series No. 10.	
	Number of experiments in each group.	Mean value of m.	Number of experiments in each group.	Mean value of m.	Number of experiments in each group.	Mean value of m.	Number of experiments in each group.	Mean value of m.	Number of experiments in each group.	Mean value of m.	Number of experiments in each group.	Mean value of m.	Number of experiments in each group.	Mean value of m.
Meters.														
0.09 to 0.11	.....	.....	.....	.....	1	0.4358	2	0.4351	2	0.4386	3	0.4393	3	0.4452
0.11 to 0.13	.....	.....	.....	.....	2	0.4345	2	0.4351	3	0.4394	3	0.4405	3	0.4486
0.13 to 0.15	1	0.4313	1	0.4314	2	0.4365	1	0.4372	3	0.4397	2	0.4444	3	0.4510
0.15 to 0.17	1	0.4307	1	0.4330	2	0.4362	2	0.4364	3	0.4424	2	0.4435	2	0.4539
0.17 to 0.19	2	0.4313	1	0.4319	2	0.4373	1	0.4370	3	0.4486	2	0.4450	2	0.4549
0.19 to 0.21	2	0.4318	1	0.4341	2	0.4383	2	0.4405	5	0.4490	2	0.4504	4	0.4618
0.21 to 0.23	1	0.4323	2	0.4349	4	0.4397	2	0.4406	2	0.4534	3	0.4506	3	0.4652
0.23 to 0.25	3	0.4333	1	0.4346	2	0.4398	2	0.4428	2	0.4583	2	0.4563	3	0.4702
0.25 to 0.27	2	0.4350	1	0.4356	3	0.4444	1	0.4442	2	0.4572	4	0.4580	3	0.4741
0.27 to 0.29	3	0.4368	1	0.4358	3	0.4471	2	0.4456	2	0.4617	1	0.4604	3	0.4780
0.29 to 0.31	4	0.4398	3	0.4377	1	0.4518	1	0.4490	.....	.....	4	0.4631	2	0.4815
0.31 to 0.33	1	0.4399	5	0.4382	3	0.4511	2	0.4508	.....	.....	3	0.4660	3	0.4864
0.33 to 0.35	3	0.4408	4	0.4393	.....	.....	1	0.4513	.....	.....	3	0.4705	4	0.4914
0.35 to 0.37	3	0.4416	2	0.4409	.....	.....	1	0.4540	.....	.....	2	0.4733	3	0.4974
0.37 to 0.39	2	0.4433	2	0.4408	.....	.....	2	0.4554	.....	.....	3	0.4762	1	0.5013
0.39 to 0.41	.....	.....	1	0.4412	.....	.....	3	0.4580	.....	.....	2	0.4797	2	0.5021
0.41 to 0.43	.....	.....	3	0.4434	.....	.....	2	0.4605	.....	.....	.....	.....	.....	.....
0.43 to 0.45	.....	.....	1	0.4455	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE 4.

VALUES OF THE COEFFICIENT m IN THE FORMULA $Q = mlh\sqrt{2gh}$, FOR A SHARP-CRESTED WEIR WITHOUT LATERAL CONTRACTION; THE AIR ADMITTED FREELY BEHIND THE FALLING SHEET.

HEAD. h.			HEIGHT OF CREST OF WEIR ABOVE BED OF CHANNEL.									
			Meters 0.20	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00	∞
			Feet 0.66	0.98	1.31	1.64	1.97	2.62	3.28	4.92	6.56	∞
			Inches 7.87	11.81	15.75	19.69	23.62	31.50	39.38	59.07	78.76	∞
Meters.	Feet.	Ins.	m	m	m	m	m	m	m	m	m	μ
0.05	.164	1.97	0.458	0.453	0.451	0.450	0.449	0.449	0.449	0.448	0.448	0.4481
0.06	.197	2.36	0.456	0.450	0.447	0.445	0.445	0.444	0.443	0.443	0.443	0.4427
0.07	.230	2.76	0.455	0.448	0.445	0.443	0.442	0.441	0.440	0.440	0.439	0.4390
0.08	.262	3.15	0.456	0.447	0.443	0.441	0.440	0.438	0.438	0.437	0.437	0.4363
0.09	.295	3.54	0.457	0.447	0.442	0.440	0.438	0.436	0.436	0.435	0.434	0.4340
0.10	.328	3.94	0.459	0.447	0.442	0.439	0.437	0.435	0.434	0.433	0.433	0.4322
0.12	.394	4.72	0.462	0.448	0.442	0.438	0.436	0.433	0.432	0.430	0.430	0.42 1
0.14	.459	5.51	0.466	0.450	0.443	0.438	0.435	0.432	0.430	0.428	0.428	0.4267
0.16	.525	6.30	0.471	0.453	0.444	0.438	0.435	0.431	0.429	0.427	0.426	0.4246
0.18	.591	7.09	0.475	0.456	0.445	0.439	0.435	0.431	0.428	0.426	0.425	0.4229
0.20	.656	7.87	0.480	0.459	0.447	0.440	0.436	0.431	0.428	0.425	0.423	0.4215
0.22	.722	8.66	0.484	0.462	0.449	0.442	0.437	0.431	0.428	0.424	0.423	0.4203
0.24	.787	9.45	0.488	0.465	0.452	0.444	0.438	0.432	0.428	0.424	0.422	0.4194
0.26	.853	10.24	0.492	0.468	0.455	0.446	0.440	0.432	0.429	0.424	0.422	0.4187
0.28	.919	11.02	0.496	0.472	0.457	0.448	0.441	0.433	0.429	0.424	0.422	0.4181
0.30	.984	11.81	0.500	0.475	0.460	0.450	0.443	0.434	0.430	0.424	0.421	0.4174
0.32	1.050	12.60	.....	0.478	0.462	0.452	0.444	0.436	0.430	0.424	0.421	0.4168
0.34	1.116	13.39	.....	0.481	0.464	0.454	0.446	0.437	0.431	0.424	0.421	0.4162
0.36	1.181	14.17	.....	0.483	0.467	0.456	0.448	0.438	0.432	0.424	0.421	0.4156
0.38	1.247	14.96	.....	0.486	0.469	0.458	0.449	0.439	0.432	0.424	0.421	0.4150
0.40	1.312	15.75	.....	0.489	0.472	0.459	0.451	0.440	0.433	0.424	0.421	0.4144
0.42	1.378	16.54	.....	0.491	0.474	0.461	0.452	0.441	0.434	0.425	0.421	0.4139
0.44	1.444	17.32	.....	0.494	0.476	0.463	0.454	0.442	0.435	0.425	0.421	0.4134
0.46	1.509	18.21	.....	0.496	0.478	0.465	0.456	0.443	0.435	0.425	0.421	0.4128
0.48	1.575	18.90	.....	.....	0.480	0.467	0.457	0.444	0.436	0.425	0.421	0.4122
0.50	1.640	19.69	.....	.....	0.482	0.468	0.459	0.445	0.437	0.426	0.421	0.4118
0.52	1.706	20.47	.....	.....	0.483	0.470	0.460	0.446	0.438	0.426	0.421	0.4112
0.54	1.772	21.26	.....	.....	0.485	0.472	0.461	0.447	0.438	0.426	0.421	0.4109
0.56	1.837	22.05	.....	.....	0.487	0.473	0.463	0.448	0.439	0.427	0.421	0.4101
0.58	1.903	22.83	.....	.....	0.489	0.475	0.464	0.449	0.440	0.427	0.421	0.4096
0.60	1.969	23.62	.....	.....	0.490	0.476	0.466	0.451	0.441	0.427	0.421	0.4092

l their corresponding lengths, H and h their heads under the flow of a given quantity of water. Then

$$Q = M\,L\,H\,\sqrt{2\,g\,H} = m\,l\,h\,\sqrt{2\,g\,h}$$

or $$M\,L\,H\sqrt{H}\sqrt{2\,g} = m\,l\,h\sqrt{h}\sqrt{2\,g}$$

or $$M\,L\,H, \tfrac{3}{2} = m\,l\,h, \tfrac{3}{2}$$

whence $$m = M\left(\frac{L}{l}\right)\left(\frac{H}{h}\right)^{\frac{3}{2}}$$

The gauging operations already described had given once for all the coefficient M for the standard weir for each value of H; and the ratio $\frac{L}{l}$ (very nearly unity) was constant for all the experiments of any one series. It remained, therefore, to measure only the heads H and h in order to apply the last formula and obtain the coefficient m.

The gauging resulted as shown in Table 3:

These values are plotted in the four upper curves of the diagram, from which it will be seen that for very small heads the height of the weir upon which depends the velocity of approach) has but little effect upon the coefficient, the several curves approaching each other where the heads are small. But under greater heads the values are often seen to rise rapidly as the height of the weir diminishes (the velocity of approach meanwhile increasing): for the curves rapidly diverge as the head increases.

We see also that in each series, it decreases with the head; and, although it did not reach a minimum within the range of the experiments, as it did in the case of the standard weir, yet the curves indicate that such a minimum exists, but also that it pertains to very small heads, with which it was not thought worth while to experiment, because in such cases (as just observed) the height of the weir has but very little effect upon the coefficient.

As the height of the weir decreases, the minimum of m appears to occur under smaller heads, while the absolute value of that minimum increases.

From a careful plotting of his experiments, M. BAZIN gives a table of values of m (Table 4), for weirs of different heights and under different heads, believing that except for very low weirs (which should be avoided) they will be found within one per cent. of the truth, provided that the arrangement of his weirs is exactly reproduced.

The coefficient μ in the last column is that for an imaginary weir of infinite height, in which case there would be no velocity of approach. The variation of μ s shown by the lowest (dotted) curve in the diagram.

As a close approximation, we may take

$$\mu = 0.405 + \frac{0.003}{h \text{ in meters}}$$

and

$$m = \mu\left[1 + 0.55\left(\frac{h}{h+p}\right)^2\right]$$

where h is the head on the weir and p the height of the weir.

Indeed, for heads between 0.10 and 0.30 meter (4 to 12 ins.) and for cases where an error of from 2 to 3% is admissible, we may be satisfied to make

$$\mu = 0.425$$

and

$$m = 0.425\left[1 + \tfrac{1}{3}\left(\frac{h}{p+h}\right)^2\right]$$

$$= 0.425 + 0.21\left(\frac{h}{p+h}\right)^2$$

Mr. FRANCIS' well-known formula,

$$Q = 3.33\,l\,h^{\frac{3}{2}},$$

when put into the form,

$$Q = m\,l\,h\sqrt{2\,g\,h}$$

becomes

$$Q = 0.415\,l\,h\sqrt{2\,g\,h}.$$

In other words, Mr. FRANCIS' experiments give for m, within the limits which he specifies,* the value 0.415.

* Heads from 6 to 24 ins., height p of weir at least twice the head h; length l at least three times the head h, crest "in thin partition;" and ends vertical.

Subaqueous Foundations.*

(*Continued from page 536.*)

In my former lecture I dealt with subaqueous foundations so far as they related to "inside works," that is, works executed in sheltered positions. I now propose to treat of works constructed under water in exposed positions, which may be termed "outside works." The character of such works is dependent on their site, the object they have to serve, the force of the waves and currents they have to resist, the depth of water, and the nature and configuration of the sea bottom. These vary so much that there are, perhaps, not two sea works existing subject to precisely similar conditions.

The practice of engineers in regard to the construction of breakwaters differs very much, and this is largely due to the fact that the forces which have to be dealt with are not ascertainable with the same accuracy, or approximate accuracy, as in the majority of other engineering works, and therefore the experience and judgment of the engineer have to play a much more important part to insure economy and safety than in almost any other branch of engineering. Many observations and experiments have been made in regard to the height and force of waves, and also with respect to the "fetch" or uninterrupted distance over which they have traveled, and formulæ deduced from these observations. Such formulæ, however, have not, so far as I am aware, been called into practical use for the designing of breakwaters. In designing such works, the engineer proceeds rather by analogy, reasoning from works successfully executed by himself or other engineers, observing the points of similitude or difference, and modifying the design accordingly. The tendency is, and upon the whole it is judicious, to provide ample strength, and whenever the designer is in doubt, to give a very wide margin indeed. In the opinions of engineers, this margin varies so greatly that I am not saying too much in stating that of two engineers, both experienced in the construction of breakwaters, one might produce a design at least twice as costly as that of the other, for a breakwater upon the same site, and to serve the same purpose. In short, the designing of breakwaters is purely empirical; useful experience has been gained from numerous failures, and a step by-step process has been pursued, leading up to the designs of the present day.

I will give a short *résumé* of the principal features of some designs of breakwaters, concluding with the most recent, one of my own works, which embodies some novel features, viz.: the Hermitage Breakwater, which is now in course of construction at St. Helier's Harbor works, Jersey. Where the exposure is somewhat limited, an inexpensive class of work may be adopted, consisting of a mound or embankment formed of roughly quarried stones

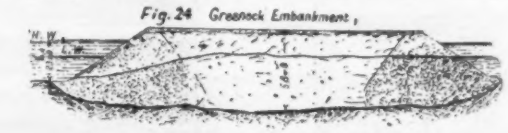


Fig. 24 Greenock Embankment.

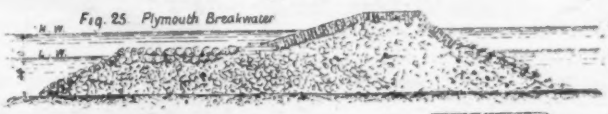


Fig. 25. Plymouth Breakwater

Fig. 26. Port Said Breakwater

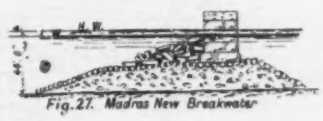


Fig. 27. Madras New Breakwater

Fig. 28. Madras Breakwater.

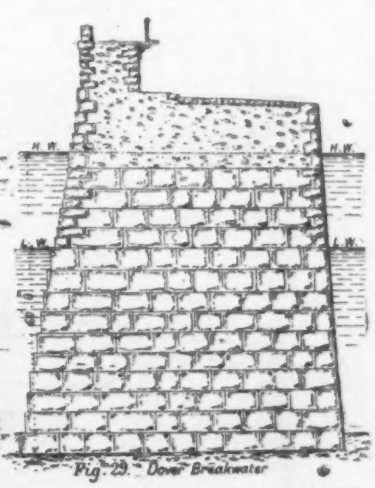


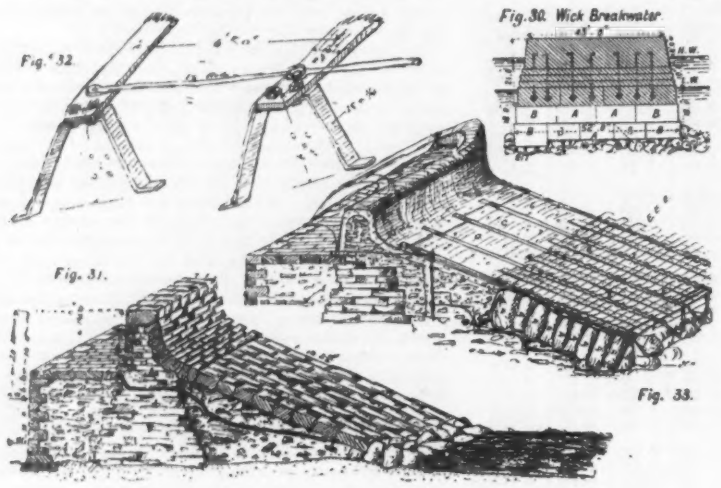
Fig. 29. Dover Breakwater

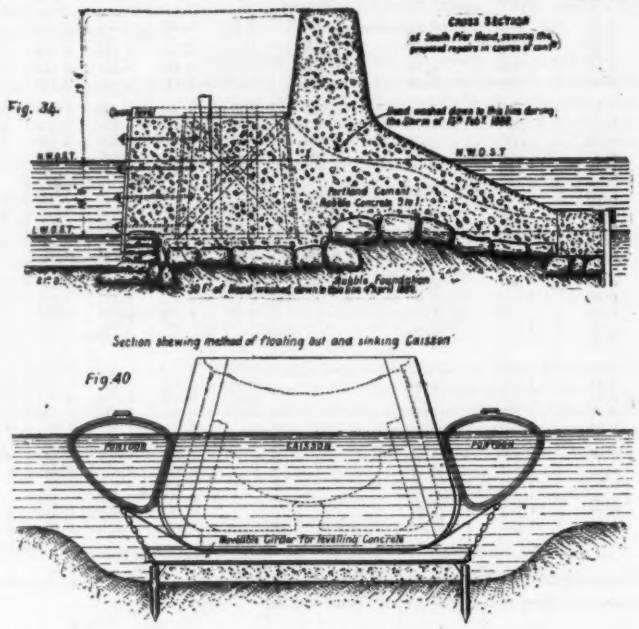
and faced with heavier stones closely laid, or with a covering of concrete blocks, of such size or weight as may be found necessary to resist the seas to which they may be subjected.

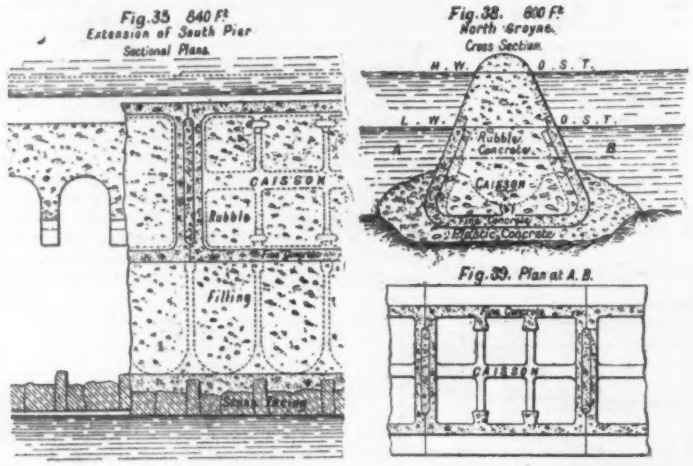
Numerous examples of this class of work are in existence, and recently I constructed in this manner an embankment (Fig. 24), forming the outer arm of a large tidal harbor at the James Watt Dock works, Greenock. This embankment is 3,300 ft. in length, 200 ft. in width at top at its widest part, and was founded in depths varying from 0 to 18 ft. at low water. Over a considerable portion of the site of the embankment, the material on which it was founded was very soft for a depth of more than 100 ft. below low water. The method of construction was as follows, viz.: Along the sites of the inside and outside slopes of the embankment trenches were dredged down to a depth of 23 ft. below low water, or 33 ft. below high water, for the reception of waste stone from the rock excavations of the James Watt Dock works; this was deposited by end tip wagons in the form of ordinary railway embankments, up to 8 ft. above high

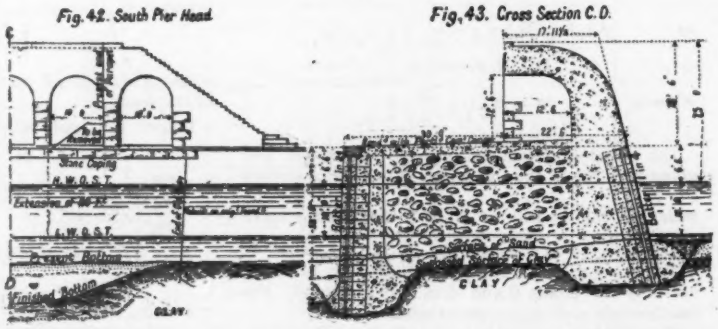
* By WALTER ROBERT KINIPPLE, M. Inst. C. E. Reprinted from *Engineering*.

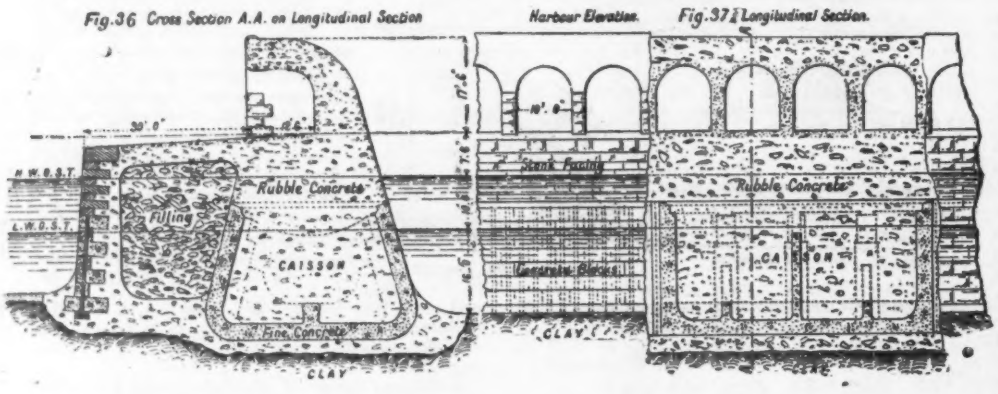
water mark, and the space between these embankments was filled up with a hearting of clay, stone, etc. During progress, the bank had to be made up from time to time, as it gradually sank into the soft material on which it was founded, the depth to which it sank being about 50 ft. below high water, or 40 ft. below low water. On one occasion, simultaneously with a very low water of a spring tide, when the embankment had nearly reached coping level, about 450 ft. in length from the tip end suddenly sank from 7 ft. to about 12 ft. This was due to the increased weight of the embankment, brought about by the base being uncovered some 2 ft. or 3 ft.











more than usual. After the embankment ceased to subside, the slopes were faced below low water with heavy blocks of stone, and above low water with rubble pitching 2 ft. 6 ins. in depth, the joints of which were filled with fine Portland cement concrete. The top of the embankment, for a width of 10 ft. back from the coping was pitched with rubble 18 ins. in depth, laid on a bed of broken stones.

In some of the iron-making districts the slag from the blast furnaces has been run out and tipped in the form of embankments for sheltering purposes, and these have answered well as breakwaters. On their inner or sheltered sides, timber wharfings and jetties have occasionally been erected, and useful berthage accommodation obtained. Works of this class, even although exceedingly cheap to construct in the first instance, are sometimes very costly to maintain, especially if there is much wasting of the slag, or if there is a concrete covering to keep the slag in-

tact: for probably in the long run it may be found that the annual cost for upkeep may equal the interest on such a sum as would have paid for the erection of a good substantial breakwater, which would have needed no such repairs. Generally, it is better and more economical to build a solid head to a slag or rubble mound breakwater than to attempt to protect the slopes by a covering of concrete, the toe of which is so easily undermined unless it be well protected with heavy blocks of concrete. Such works, even under the most favorable conditions, are only suitable for very moderate exposures; but where works are completly exposed to the Atlantic, Indian, or Pacific Oceans, they should be of the most solid description, and the arrangements for their execution such that at almost any stage of their progress they, together with the plant employed, should be capable of resisting any storms that may arise.

In the earlier breakwaters of any magnitude, such as Plymouth, the method adopted was an extension of the rubble mound system; but the magnitude of the work, compared with any work at that date of similar construction, rendered it of great importance that the utmost care should be bestowed on the design and construction of the work, and that the materials should be arranged to give the most effective results. This was done by depositing them in layers according to their sizes, and on the outside of the mound a coating or covering of very large-sized stones was laid down. The Plymouth Breakwater (Fig. 25) is 5,100 ft. in length, founded in a depth of 33 ft. at low water, and is carried up to 2 ft. above high water. The range of tide is 15½ ft. at springs. The slope on the sea face is paved with heavy blocks of granite set in cement, from low water up to the top, and all are firmly cemented and cramped together. The cost of the works appears to have been about £300 per foot run, but there is a constant annual expenditure for maintenance.

I have shown (Fig. 26) a section of Port Said Breakwater, founded in a depth of about 25 ft. of water below ordinary sea level, and which consists of a base or mound of rubble deposited up to a level of about 18 ft. below sea level; and on the rubble, up to 12 ft. above sea level, it consists of a mound of 20-ton concrete blocks, partly launched from the decks of barges, and partly deposited by sheers mounted on a barge. The employment of a mound of large concrete blocks, is a decided step in advance of the protected rubble adopted at Plymouth, resulting in a reduction of material employed; in increasing the stability of the upper portion of the work, which is subjected to the greatest force of the waves; in being executed for a smaller first cost; and in greatly lessening the expenditure for repairs. A still further development is shown in the section of the Madras Breakwater (Figs. 27 and 28), which consists of a vertical wall of large concrete blocks founded on a rubble mound, the surface of the latter being at a level of about 22 ft. below low water. The total depth at the outer end is 45 ft. at low water, the rise of tide 3 ft. 6 in., and the total height of the work from foundation to coping about 50 ft. The widening of the rubble base, the mound of large concrete blocks against the sea face, the concrete bags on the inside, and the capping of concrete (Fig. 27), are the additions to the ordinary section of the work as proposed for the new outer arm. At the Manora Breakwater, Kurrachee, the sloping concrete block system was first adopted in 1870 by Mr. William Parkes, and has opened up a new era in concrete block laying. The system of sloping courses, although excellent, is not new, for it was formerly used in connection with the building of ordinary dry stone harbor walls and sea piers. It avoids the cost and trouble in connection with the bonding, leveling, and the making of the beds and joints fair, as in horizontal coursed ork

Dover Breakwater (see Fig. 29), 2,100 ft. in length, was built at the rate of about 90 ft. linear per annum, between the years 1847 and 1871, and cost upon an average about £323 10s. per foot run, exclusive of engineering and other expenses, but inclusive of these about £360. Such a work as that at Dover is the best example extant of the vertical wall type of construction. The solid stratum of chalk on which it is founded was dressed down to an even surface, for the reception of the first or foundation course of concrete blocks, at about 59 ft. below high water or 40 ft. below low water. From foundation up to within a few

feet of high-water mark, it is wholly built of concrete blocks in horizontal courses, laid dry. From these blocks up to quay level, it is built with concrete *in situ*, and from low water up to coping it is faced with granite. The parapet is carried up to about 25 ft. above high-water mark. The width of the breakwater at quay level, or at about 10 ft. above high water, is 47 ft., and the width at foundation level 65 ft. The total height from foundation to quay level is 69 ft., and the top of the parapet stands about 15 ft. above quay level. This method of founding on a solid bottom, at 40 ft. below low water, owing to its great cost, and the comparatively slow progress made during construction, has not been repeated. The work, however, is a masterpiece of engineering, and when designed in 1847, was very far in advance of any method then in use. A work of a similar vertical section can now be constructed on an absolutely monolithic system, from foundation to coping, with rubble masonry blocks, faced with granite ashlar, having every joint and bed, both above and below low water, filled up with neat cement, for less than half its cost, and in 10 instead of 24 years.

Wick Bay, owing to its great exposure to the North Sea, the deep water outside, and its bell-like form, is subjected to very heavy and destructive seas, which, on entering the bay, are gradually heaped up or contracted by the narrowing of the bay landwards, and so their forces are almost wholly spent vertically by rising to great heights; that is, their reduction is not much influenced, as in most cases, by the gradual increase in width and reduction of depth of water landwards. When I gave evidence in Aberdeen on Aug. 6, 1883, before the "Sub-committee appointed to investigate the question of the most suitable place for a harbor of refuge on the east coast of Scotland," I alluded, among other things, to the failure of the Wick Breakwater. This work was commenced in 1833, and after being in progress for about nine years, a severe gale, which occurred in December, 1872, carried away about 150 ft. of its seaward end, which included the 1,350-ton block at its head, to which so many engineers have from time to time made reference. At the end of June, in the year 1880, and again in March, 1881, I made examinations of the ruins of this breakwater, which at the latter date had, through succeeding heavy gales from the year 1872 down to that of the 11th and 12th of March, 1881, extended from its head shorewards for a length of 500 ft., leaving little more intact than the shallow water portion or shore end of the work. The mass of 1,350 tons, which was moved entire, was not one block, cast *in situ*, but consisted of a block 26 ft. in length by 45 ft. in width, and by 11 ft. in depth, of cement rubble work built *in situ*, and weighing upward of 800 tons, and this was connected by 3¼-in. diameter wrought iron rods to a course consisting of 80 and 100-ton blocks immediately below it, weighing some 550 tons. All the blocks under water were laid dry, that is without any attempt being made to fill up the open joints with cement. Had each of such blocks borne its fair share of the weight of the concrete-in-mass superstructuere, or better still, had the breakwater been a monolith from foundation to cope, no such accident as that described could have occurred, for the breakwater was of ample section or weight to resist the forces it had to encounter, but being of compound construction, composed of a loose rubble mound, with blocks of concrete laid dry on top thereof, and again on the tops of these blocks a monolithic superstructure of cement rubble concrete built *in situ*, the stability of the work, as a whole was dependent upon that of its weakest component part, so that if by any means the rubble base or concrete blocks, laid dry on top thereof, that is having open joints and beds, became disturbed, and the weight of the concrete-in-mass superstructure thus no longer borne uniformly by the whole of the dry blocks, one or more of such blocks would soon get dislodged, and an opening or breach once formed would extend very quickly.

In the rubble base of a breakwater, such as that at Wick, the outer margins are much more liable to subside, or are more easily affected by storms than the central portion, and, further, the faces of the slopes have a constant tendency to flatten and assume an angle or section of repose. From this it may be concluded that the commencement of the failure at Wick was principally due to one or more of the outer blocks *B B*, *B*¹ *B*¹ (Fig. 30), becoming loosened, probably from subsidence of the rubble, and thus the 1,350-ton upper block, being almost wholly supported on the central blocks *A A*, and rocking on them, under the action of the waves, still further punched down or loosened the lower outer dry blocks in their beds, until finally they were dislodged, leaving the 1,350-ton mass (or 980 tons in water) resting upon the blocks *A A*, upon which it was slewed round as on a pivot, and deposited inside the breakwater. The shelter afforded to a portion of the bay and to the old Pulteney Town harbor works, by this breakwater during its short life was of great service, but its gradual destruction by successive gales, down to the beginning of 1880, once more subjected the harbor works to the exceptionally heavy seas to which the Bay of Wick is exposed.

During a heavy gale on the night of Feb. 15, 1880, the head of the old south pier (Fig. 31) was seriously damaged, over 2,000 tons of stone facing blocks of from 3 ft. to 4 ft. in depth from the slope, and rubble from the parapet and mound, being washed down, and on the 18th of the same month I was called in to advise as to the best course to pursue to repair the damage in the shortest possible time. The steps taken were first to pin and cement up the loose ends of the stonework, and then to cover up the the mound of rubble as quickly as possible with concrete *in situ* up to the original slope line, and to restore the parapet. The work of restoration was in hand and progressing rapidly and well, when on April 4, 1880, a heavy gale carried away 30 ft. of the damaged head down to nearly low-water mark, seawards of that portion which had just been repaired, and which stood the gale exceedingly well. Beyond a few planks, barrows and flat bar rails, it was impossible to obtain suitable plant for carrying on the work. I, therefore, resolved to cast blocks of concrete *in situ* in compartments, having frames formed of stools of 6 ft. to 8 ft. in height of flat bar rails, bent into an **A** form (Fig. 32) to serve as trestles, which were placed 6 ft. apart, and carried heavy flat bar rails, which were used as rafters, to which 1½ plowed and tongued flooring boards were lashed, by ¼-in. diameter ropes to centre-bit holes, to the undersides of the rafters and to the legs of the trestles. Along the junction side of the block to be cast, with that of the succeeding block, heavy bags of shingle *D D* (Fig. 33) were stacked, to form a temporary wall during the casting of the block in the compartment. To prevent wash, old sails were nailed to the roofing and end boarding laid over the side walls of sacks of shingle, and on the floor over open rubble. The whole of the framing, boarding and covering with sailcloth was easily completed as the tide receded, and immediately it left the compartment the concrete (which had been allowed to partially set for two or three hours), amounting to from 70 to 145 tons per compartment, was laid in in a couple of hours, and its top surface under the roofing rammed in solid with a strong fine concrete. The heavy seas, as the tide rose, had no effect on the newly cast blocks, and after two or three days the framing was removed, when in every case sound work was obtained, and as far as I can learn, no disintegration has taken place in the plastic concrete, now 9 years old.

The work was carried out in accordance with an original sketch, which was laid before the Pulteney Town Harbor Commissioners on April 7, 1880, and approved of by them (Figs. 33 and 33). In executing the concrete *in situ* work down the slope, considerable difficulties—owing to the few hours men could work at spring tides—were encountered in founding the lower portions of the slope and the toe-blocks at about low water mark, several of which were successfully cast, but at a considerable expenditure of time and money, and, therefore, I advised that as soon as possible sheeting piles should be driven well down into the clay to form a toe, to be backed with concrete, grouted up rubble, and coated with Medina cement, and so prevent undermining, which I believe has since been done. During the progress of the work, some of the concrete facing was damaged by the exposed rubble being washed out from under the concrete before it could be covered up.

Figs. 35, 36, and 37, show plan, cross section, elevation, and longitudinal section of the proposed 840-ft. extension of the south pier, dated February, 1880, illustrating the use of concrete caissons for founding facings of concrete made out of water up to a few feet above low water, so as to prevent disintegation, as concrete work out of water in the form of blocks and allowed to harden seldom gives way. In this case the outer skin of the caisson next the sea takes the place of facing blocks. Figs. 38 and 39 show cross section and plan of proposed groyne or pier of 800 ft. in length on the opposite side of the bay to that of the proposed extension of the new south pier, also using concrete caissons, as for the south pier and the groyne. Fig. 40 shows section of method of floating and sinking the concrete caissons, and leveling the beds for the reception of the same. These drawings I prepared in January and February, 1880, for the Wick Harbor Commissioners, in support of their application to the Treasury for the remission of the debt or loan of £60,000, so as to enable them to proceed with the extension of the south pier and other works.

Fig. 34 shows a cross section of the repairs to the head as executed (dated April 21, 1880). Figs. 42 and 43 show elevation and cross section of the 40 ft. length of the proposed extension of the south pier prepared in March, 1882, as a modification of the design for caissons, dated February, 1880, and show the work to be carried out by the use of small dovetailed concrete blocks, such as were at that date being so successfully used at Girvan, after the abandonment of the costly and troublesome timber framing and molds. These small blocks were readily and easily laid when there was a good splash on, formed a most excellent and durable face and a cement-tight mold for the reception of the concrete *in situ* backing, which was thoroughly united to the dovetailed blocks by neat cement grout poured down the holes in the centers and joints of the blocks. The backing was brought up in layers with the blocks, and finished off at each tide's work at half way up the last course of blocks, so as to form a good junction with the succeeding tide's work. Generally upon these designs—omitting the caissons or small dovetailed blocks—a length of about 150 ft. of the extension work has been carried out; that is to say, the concrete *in situ* system of depositing within frames, from foundation to cope, has been adopted.

(To be continued.)

Legal Decisions of Interest to Engineers.

Modification of Contract by Custom.—Where a contract is entered into by which one party agrees to buy at a certain price all the railroad ties the other party can buy, he will not be permitted to show that according to custom that price was the first grade, and that such ties as might be delivered of a poorer grade should be graded down and paid for at a lower rate, as the contract contained no such provisions, and in order to justify this under a custom of trade, it must be shown that the other party had notice of the custom, or that it was such a universal usage as should have been known to him. (Larrowe v. Lewis, Supr. Ct. of New York, 11 N. Y. Supp., 342.)

Injury by Unforeseen Causes.—A master cannot be held liable for injuries sustained by a servant which could not be foreseen, as there can be no negligence in failing to provide against them. Where a repairer in a car shop is injured by reason of compressed air in a force pump which he was ordered to clean in the course of his business, he cannot recover unless he shows that the compression of the air was due to a defect in the pump for which the master was responsible. (Kelly v. Forty-Second St. M. & S. N. Ry. Co., Supr. Ct. of New York, 11 N. Y. Supp., 344.)

Responsibility of Municipality for Sidewalks.—Where a municipal government has the means and the power, and the duty is by law imposed on it, of keeping its streets and sidewalks in repair, it is liable for the neglect of such duty; and where, in constructing a sidewalk, a section of natural rock is incorporated into it without being smooth and prepared for safe passage over it, the village is liable for injuries sustained by persons who fall by reason of irregularities in the surface of such walk. (Higgins v. Village of Glens Falls, Supr. Ct. of New York, 11 N. Y. Supp., 289.)

Negligence in Care of Spark Arresters.—In an action to recover damages from a railroad company for property destroyed by fire, where it appears that cinders as large as hickory nuts were thrown from the smokestack of the engine, and that spark arresters which would permit such cinders to escape could not be in proper working order, it is correct to apply the rule of law that if those in charge of the engine knew of the defect and did not repair it, the company was guilty of negligence. (Knight v. Chicago, R. I. & P. Ry. Co., Supr. Ct. of Iowa, 46 N. W. Rep., 1,112.)

THE VERRUGAS VIADUCT, built in 1871 and destroyed in 1889, has been re-erected by the W. R. GRACE syndicate. This new bridge on the Oroya Ry., in Peru, is of the cantilever type, 575 ft. long, with a suspended span of 105 ft. The track is 252 ft. above the deepest point in the gorge crossed. The bridge was designed by Mr. L. L. BUCK, M. Am. Soc. C. E., the builder of the original Verrugas Viaduct, and was constructed by Cooper, Hewitt & Co., of Trenton, N. J. As will be seen by reference to our issue of July 27, 1889, the new bridge is a marked improvement on the old one in design. The structure of 1871 had three towers, or piers, one almost in the deepest part of the gorge, and four Fink trusses. The new bridge has the same length as the old one, 575 ft., but two short towers on the sides of the gorge support two cantilever spans of about 235 ft. each and a suspended span of 105 ft.

PUBLIC BUILDINGS in the last fiscal year cost $4,075,048, according to the report of Supervising Architect WINDRIM. Of this sum $3,691,341 was paid for sites and new buildings; the remainder was expended in repairs and alterations. Sixty-nine buildings are now being constructed; 21 were finished during the year; designs have been prepared for 26, and 27 new buildings have been provided for. The total of buildings completed and occupied is 250, and the sites for 100 more have been acquired, but no work done upon them.

THE BOSTON CITY HALL is to be enlarged at an expense of $1,000,000, says a Boston news item. The present building was dedicated in 1865, but the increase in departments and force employed has made the extension necessary.

THE PROVINCE OF ALBERTA, on the East foot of the Rocky Mountains in British Columbia, promises enormous mineral wealth, according to the preliminary report of Mr. W. S. DRURY, of the Dominion Topographical Survey. In this region anthracite coal is reported in seams 20 to 50 ft. thick; copper ore 28% fine, silver, lead and gold were discovered. Evidence also goes to show that one of the greatest petroleum fields in the world underlie the plains of Alberta, and natural gas is there already utilized in a limited degree.

THE SIAMESE PAY FOR ENGINEERS, of the higher grades, is $3,000 to $3,500 per annum, says *Kuhlow's German Trade Review* in speaking of the railway which the Government of Siam now proposes to build.

A LECTURE ON FOUNDATIONS, illustrated by stereopticon views of many of the principal bridges of this and other countries, was delivered, Dec. 16,

by FRANCIS COLLINGWOOD, of the class of 1855 of the Rensselaer Polytechnic Institute, before the students of that institution.

THE RAPID TRANSIT COMMISSION of New York is now made up of the following members, recently appointed by Mayor GRANT: WILLIAM STEINWAY, JOHN H. STARIN, SAMUEL SPENCER, EUGENE L. BUSHE and FREDERICK P. OLCOTT. The first two were members of the old board. Mr. SPENCER is a member of the firm of Drexel, Morgan & Co., and is a skillful railway expert. Mr. BUSHE is a lawyer and Mr. OLCOTT is the president of the Central Trust Company. The retiring members are Messrs. O. B. POTTER, WOODBURY LANGDON, and the late AUGUST BELMONT.

THE PRICE OF ALUMINUM is likely to steadily and rapidly fall to at least 50 cts. per lb., and probably lower; in fact, the only thing which is holding the price at $2 or less per pound is that all which can be produced with the present plants is readily salable at that price, and the immensely wider market which will open when the price is down to 50 cts. cannot possibly be supplied by any works as yet existing. Both the Pittsburg Reduction Co. and the Cowles Electric Smelting & Aluminum Co. are preparing to erect greatly larger works, and Mr. COWLES has publicly predicted that the price will eventually fall to $200 to $300 per ton, or 10 to 15 cts. per lb., while at 50 cts. it competes with copper at 17 cts. for many uses. There appears to be no doubt that aluminum is to play a highly important part in the arts hereafter, perhaps coming second to iron only.

THE FAILURE OF NATURAL GAS is the vital topic in Northwestern Ohio, and in the Pittsburg region. A Cleveland correspondent says that the wells of Lancaster, O., show decreased pressure and failing supply; the Columbus wells are so weak as to force manufacturers to return to coal; at Upper Sandusky, the Findlay wells have been cut off entirely, and at Toledo, crude oil is being substituted for gas, owing to a failing supply of the latter. As some compensation the failing gas-wells are becoming oil producers, and it is now supposed that crude oil will very generally supplant the natural gas as a heat producer.

DRILLING SQUARE HOLES IN METAL was a problem first practically solved by the Ainley-Oakes machine, by the use of a set of cams that guided the point of the cutter around the sides of a square of given size. The objection to this first machine was that it left a small fillet in the angles which had to be cleared out afterward. A new machine is now out, called the Tyler-Ellis drill, which, says the London *Times*, has a spindle moving about a ball joint that enables the cutter to follow any mathematical outline desired. It also cuts clean angles.

A THOUSAND-YEAR OLD WOODEN CHURCH is still in constant use at Bury-St.-Edmunds, in England, says the *American Architect*. It is supposed to have been built in 870 as a temporary shelter for the body of ST. EDMUND. The walls are made of thick planks on a plinth of brick. There is also a square wooden tower; but the roof is of the date of QUEEN ELIZABETH.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Indiana.—A press dispatch from Brazil, Ind., says:

For five years past the Chicago & Eastern Illinois has enjoyed a monopoly in transporting Indiana coal to the Chicago market. Two formidable rivals now propose to enter the field—the Illinois Central and the Louisville, New Albany & Chicago. The former, through the Chicago, Paxton & Cayuga road from Paxton, Ill., to Brazil via Cayuga, a distance of 120 miles, taps the coal fields direct. The right of way has been purchased and within a year the road will be in operation. The Louisville, New Albany & Chicago has 200 men at work constructing a roadbed between Bridgeton and Carbon. The ultimate design is to reach Evansville via French Lick. Besides these the Indiana Midland proposes an extension to Brazil.

Baltimore & Ohio.—This company is rapidly securing additional rolling stock for its increasing traffic. The new yards at Cumberland, in which trains from the West will be divided and made up for Baltimore, Philadelphia and New York, will soon be in use, and the yards at Trinidad, on the Washington branch, near Washington, are nearly completed. A large round house and repair shops have also been located at Trinidad. At Brunswick, near Point of Rocks, on the main stem, large transfer sheds, freight warehouses and tracks for the siding of over 1,000 freight cars have been constructed. At Benwood, W. Va., new freight accommodations have also been provided. The company also contemplates the construction of a branch line from Brunswick to Middletown, Md., 12 miles.

Western New York & Pennsylvania.—This company has taken out a charter for a road to be known as the Oil City & New Castle R. R. The line will really extend from Oil City to Stoneborough, a distance of 45 miles, paralleling the Lake Shore road the entire distance. The company already owns a line from Stoneborough to New Castle, and it has been running through trains between New Castle and Oil City under a trackage contract with the Lake Shore & Michigan Southern Co., which entitled it to use the latter's road. The trackage contract recently expired, and the company will, therefore, build its own line. The road will cost about $70,000, and will be built in the course of the coming year.

Philadelphia & Reading.—The Reading Terminal bill, allowing the Philadelphia & Reading Railroad Company to extend its tracks in Philadelphia from the present terminus at Ninth and Green Sts. to Twelfth and Market Sts., about 10 blocks nearer the center of the city, by means of an elevated railroad, has passed the Common Councils by a vote of 104 to 3. The bill needs only the mayor's signature to become a law, but his attitude toward it is not so certain. The general opinion, however, is that the bill will become a law, and the company will gain the terminal location for which it has fought for several years. It is estimated that the extension of the road will cost between $7,000,000 and $8,000,000.

Projects and Surveys.

Plymouth County.—This company proposes to construct a railway from East Waymouth to South Marshfield, Mass.

Maryland.—A press dispatch says:

Another railroad over the Blue Ridge Mountains is projected. It will pass through the northeastern section of Frederick Valley, crossing Catoctin Mountain at Mount Katalpa, 3 miles from Frederick, and from this point on through Frederick to Rocky Ridge, a distance of about 18 miles. From Rocky Ridge a branch road extends to Emmettsburg, Md. An extension from Emmettsburg to Gettysburg, a distance of 11 miles, is also proposed.

Portland & Rumford Falls.—Parker Spofford, of Bucksport, Me., Chief Engineer, is now revising the location of this road. It is understood that the company proposes to break ground for the extension in the early spring, probably as early as April. It is expected that proposals for the building of it will be made by Col. Greene, who built the road from Bangor to Bar Harbor, and Brown Bros., now engaged in building the Phillips & Rangeley R. R., narrow gauge, and Mitchell, of Bucksport, who is now engaged on a railroad in Canada. The company hope to have the road complete to Rumford Falls in the fall of 1891.

Collingwood & Bay of Quinte.—The projectors of this Canadian railway are making endeavors to secure the capital necessary for its construction.

Utica & Prospect.—G. C. Ward, Boonville, N. Y., Chief Engineer, has completed the surveys for a railway from Prospect to Utica, N. Y.

Philadelphia Belt.—The Belt Line R. R. bill has passed the Philadelphia Common Councils by a vote of 103 to 1. The bill provides for the construction of a railroad, 25 miles long, along the Delaware River front and around Point Breeze to the Schuylkill River. The projectors of the road state that it is to be built solely in the interest of Philadelphia commerce, and any railroad that chooses to connect with the Belt line may do so, thereby gaining access to the harbor.

SOUTHERN. Existing Roads.

Columbia, Newberry & Laurens.—This company has completed 49 miles of track between Columbia and Jalapa, S. C., since Jan. 1, 1890.

Owensboro, Falls of Rough & Green River.—This road has completed its line from Dempster to Falls of Rough, Ky. The road opens a fine timber section.

Atlantic Coast Line.—The stockholders of the Manchester & Augusta R. R. have authorized the completion of this road from its present terminus about 20 miles south of Sumter, S. C., to Augusta, Ga. The road is now in operation from Sumter to a point some distance south, and when completed will give a valuable line through the central portion of the State.

Projects and Surveys.

Waterloo, Summerville & Otranto.—A bill is before the South Carolina Legislature to charter a railroad company by this name.

Ocala & Silver Springs Transfer Co.—This company has been chartered to build a railway from Ocala to Silver Springs, Fla., 6 miles.

Camden, Chester & Gaffney City.—Contracts for the construction of this South Carolina railway will be let about Jan. 1. The locating surveys are now in progress.

Anderson & Southport.—The bill to incorporate this company has passed the South Carolina Legislature. The road is to run from Anderson through Abbeville, Newberry, Fairfield, Kershaw, Darlington, Laurens, Florence, Marion and Horry to the North Carolina State line in the direction of South Port, N. C.

NORTHWEST.—Existing Roads.

Minneapolis, St. Paul & Sault Ste. Marie.—In a recent interview ex-Gov. Pillsbury of Minnesota stated that the "Soo" line would build 800 miles of road in the Dakotas next season. The Bismarck and Jamestown branches will be completed.

Chicago, Fort Madison & Des Moines.—It is officially stated that this company will build its line to Ottumwa, Ia., during the coming season.

Chicago & Ohio.—Press dispatches state that work will commence soon on a line from Sidell, Ill., to Chicago, Ill.

Pacific Short Line.—L. L. Bierbower has been appointed receiver of this railway, on plea of the New York stockholders.

Projects and Surveys.

Winnipeg & Hudson Bay.—A press dispatch from Ottawa, Ont., says:

"Mr. Hugh Sutherland, President of the Winnipeg & Hudson Bay Ry., arrived here recently from England, whither he went to float the bonds of the projected road. He says his mission was successful, but various details have yet to be arranged with the Dominion Government, which has awarded a land grant of over 8,000,000 acres. It is proposed to establish a fleet of specially-built steamships on the route between Fort Nelson, on Hudson's Bay, and England.

SOUTHWEST.—Existing Roads.

Kansas City, Fort Smith & Southern.—The extension of this road to Sulphur Springs, Ark., has been completed. It is the intention of the company to extend the line to Fort Smith, Ark., next season.

San Antonio & Aransas Pass.—Receiver Yoakum states that there is no immediate prospect of completing the partly graded extension to Waco, Tex.

St. Louis & Eastern.—The first 12 miles of this road has been placed in operation from Venice, Ill., northeast to coal mines east of Peters, Ill. A further extension of the road for about 41 miles is now being surveyed.

Louisiana Nickel Plate.—A project is on foot to build a line of railway from a point on the Vicksburg, Shreveport & Texas R. R. to timber lands. President, H. G. Allen, Huntington, La.

ROCKY MT. AND PACIFIC.—Existing Roads.

Foulwater Bay & Yaquina.—Contracts have been let for the construction of a railway from Foulwater Bay to Yaquina, Ore.

White River.—Four and one-half miles of this railway from Buckley, Ore., to timber regions is under construction. It is proposed to extend the line 25 miles further in the near future. The officers are: President, E. M. Goss; Treasurer, D. H. McNeally, and General Manager, C. W. Joynt.

Tacoma Belt.—The surveys for this line are being rapidly pushed to completion. The road is to be 36 miles in length and will include a portion of the Northern Pacific track.

Tacoma & Steilacoom.—It is expected to have this railway completed in about two months. The grading has been completed with the exception of a few miles at Steilacoom. There are now about 200 men now at work.

Great Northern.—Tracklaying is now progressing on the Pacific extension of this road at the rate of 2 miles per day. Work will be pushed vigorously on the section east of the mountains until winter sets in, when the 2,000 men now at work on this division will be put at work on the division west of the mountains, where about 6,000 men will be employed.

Union Pacific.—Work on the extension from Portland to Seattle has been temporarily suspended.

CITY TRANSIT.

Electric Railways.—New lines or extensions are proposed at Dunkirk, N. Y.; Augusta, Ga., address Col. D. B. Dyer; San Antonio, Tex., address T. Delafield, 95 Liberty street, New York City.

Biddeford, Me.—The directors of the Biddeford & Saco Horse R.R. have discontinued the car service until spring, and have sold a number of their horse to the Boston West End Co. It is reported that when the road is operated again in the spring electricity will be the motive power.

Windsor Locks, Conn.—A local newspaper states that a petition will be introduced in the coming legislature for a charter to construct an electric railway for freight traffic principally between this town and Poquonnock.

Jamestown, N. Y.—The Common Council has given the Citizens' Street Ry. the privilege to construct and operate an electric railway. The company pays $20,000 for the right.

Savannah, Ga.—The recently incorporated Electric Railway Co. has elected the following officers: President, J. S. Collins; Vice President, W. C. Charlton; Secretary and Treasurer, W. K. Wilkinson. The system to be used has not yet been selected.

Cincinnati, O.—The City Council has passed an ordinance authorizing the construction of "Route 24" of the street railway system. This is the double track electric line on College Hill.

Kokomo, Ind.—Snow & Avery of Detroit have secured a franchise for an electric railway here.

Milwaukee, Wis.—The Pabst Brewing Co. are reported to contemplate constructing an electric railway from their breweries to the St. Paul Ry. station.

Cedar Rapids, Ia.—The Cedar Rapids & Marion Ry. and the Cedar Rapids Street Ry. were recently sold to a

local company of which P. E. and S. E. Hall, W. D. Douglas, J. S. Ely and G. W. Bever are the leading members.

Albuquerque, N. M.—The Street Ry. has been formally turned over to the Electric Street Car Co., Dr. C. E. Winslow, president. The company hope to have their electrical cars running within 60 days.

Horse Railways.—*Memphis, Tenn.*—The city council has ratified the long-disputed contracts with the Consolidated Street Car Co., which was purchased some time ago by the Holmes Syndicate for $1,000,000. The company promises to begin to substitute electricity for mules by April 1, 1891.

Chicago, Ill.—C. B. Holmes has resigned the presidency of the National Construction Co., usually called the Holmes Syndicate. D. G. Hamilton has been elected to the vacant office. The company owns railways in Chicago, St. Louis, Memphis and other cities.

Cable Railway.—*Brooklyn, N. Y.*—It is reported that specifications for the road on Montague street are nearly completed and that contracts will be given out at an early date. Eugene G. Blackford will give further information.

Pneumatic Railway.—*Detroit, Mich.*—The Fort Wayne & Elmwood Ry. will shortly test the Jarvis system of pneumatic railways, in which powerful air compressors supply air to 6-in. pipes laid parallel with the track. Every 500 ft. a connection is made with a cistern in the middle of the track, from which the motor on the car is supplied. An experimental line has been operated in Lansing, but this will be the first practical test of the system.

New Companies.—Auburn Park Electric Light, Power Heat & Railroad Co., Chicago, Ill.; capital stock, $30,000. Prouty Street Car Motor Co., Chicago, Ill.; capital stock, $ 00,000; incorporators, E. Prouty, J. L. Francis, W. S. Gooding. Dixon, Ill., Street Ry., capital stock, $150,000; incorporators, M. McRoberts, F. C. Crowley, J. A. Blunding. Elkhorn Motor R. R., Baker City, Ore.; capital stock, $300,000; incorporators, T. F. and A. P. Campbell, D. W. Yelson.

HIGHWAYS.

Pennsylvania.—The bad condition of a road in Allegheny County recently caused the overturning of a wagon, by which the driver was killed. The coroner thought that the Legislature should take some action in regard to the repair and maintenance of public roads.

Alabama.—The Montgomery *Advertiser* had the following recently:

Before the assembling of the General Assembly there was much discussion among the press and people of the State, concerning the public road system, and the opinion was unanimous that a change was needed, and that some means should be devised to improve and make passable the highways of the State How to do it was the enigma, and now that 25 days of the General Assembly have passed we have had not even a proposition for the settlement which attracted general attention. Our public highways are a reproach and reflection upon this section, and we need not expect our lands to be developed and advanced to anything like their proper value until we adopt some system which will insure passage over the roads most of the year, at least. A pointer might be gained from the fact that in Tennessee the Vanderbilt University instructs free of charge one person from each county to supervise roads. Why could not that be done at the University and the Agricultural & Mechanical College.

BRIDGES, TUNNELS AND CANALS.

Spokane Falls, Wash.—Oskar Hubar, City Engineer. Bids for cantilever bridge 802 ft. long, roadway 40 ft., two sidewalks each 8 ft. wide, have been received as follows: San Francisco Bridge Co., $112,500; Wrought Iron Bridge Co., Canton, O., $111,990, $110,490; California Bridge Co. $121,450; Milwaukee Bridge Co., $105,670; Pacific Bridge Co., Portland, Ore., $120,000; Smith Bridge Co., Toledo, O., $107,000. Contract awarded to the Smith Bridge Co.

WATER-WORKS.

NEW ENGLAND.

Canaan, N. H.—A. M. Shockford informs us that the Crystal Lake Water Co. put their works in operation Dec. 20. Secretary, C. O. Barney. Population, 500.

Franklin, N. H.—The following is from W. F. Daniel, one of the commissioners:

The town will buy for $25,000 the Aqueduct Co.'s plant, and early in the spring will put in complete works, pumping from springs to a reservoir. Population, 2,500.

MIDDLE.

Albany, N. Y.—Surveys are being made of a proposed new source of gravity supply in Guilderland. The work is in charge of J. M. de Verona.

Brooklyn, N. Y.—It is reported that the city has purchased the plant of the Long Island Water Supply Co., organized about five years ago to supply the town of New Lots, now the 26th ward of the city. The plant consists of 8 wells, a 3,000,000-gall. pumping plant, a 4,000,000-gall. reservoir and 51 miles of mains.

Franklinville, N. Y.—The supply main from Lyndon springs has been completed, and the works will soon be in operation.

Northville, N. Y.—The following is from E. B. Baker, Engineer, Gloversville:

The village will let contracts for gravity works about Feb. 15. J. R. Van Ness is Secretary.

Rochester, N. Y.—Chief Engineer Emil Kuichling has reported on an additional water supply from Hemlock and Canadice lakes, the present principal source, Conesus Lake or Lake Ontario. We abstract from the report as follows:

Lake Ontario is rejected because of the greater expense of a supply from this source. The estimates show that for a daily supply of 15,000,000 galls. from Hemlock and Canadice lakes the cost would be $1,975,000, and for the same amount from Conesus Lake $1,809,000. Both estimates are for a 36-in. cast-iron main, about 20 miles long; each includes a new reservoir, but neither includes the cost of water rights. Mr. Kuichling estimates that the water rights at Hemlock Lake would cost less than at Conesus, while the yearly cost for the sanitary protection of Conesus Lake would be greater than for that of Hemlock, so that the Conesus Lake supply might be called $11",000 cheaper than the other. The city now has water rights at Hemlock Lake and there are reasons why the available supply here should be used before going to another source. The report is given in full in the Rochester *Union and Advertiser* for Dec. 20.

South Orange, N. J.—The following is from C. Ph. Bassett, Engineer, Newark:

The works were to be put in operation Dec 25. The village owns the distribution and obtains its supply from the plant of the Mountain Water Co. at Summit. The latter company has a 10-in. main, 6 miles long, extending from the pumps to South Orange through Deantown, Milburn and Wyoming and near Short Hills. Probably all these localities will be supplied during the coming year. H. H. Hart is Chairman of the South Orange Water Commissioners.

Homestead, Pa.—The following is from M. P. Schooley:

The city has voted $70,000 for works, and a vote will be taken to increase the amount to $100,000. Contracts will not be let until spring. The supply will be pumped from the Monongahela River to a reservoir. J. M. Hoover is Chairman of the Water Board, and Jacob Schenneller, Pittsburg, is Engineer. Population, 8,000 to 10,000.

SOUTHERN.

Milledgeville, Ga.—The following is from P. W. Coraker, city clerk:

A franchise for works was granted Dec. 19 to Wheeler & Parks, Boston, Mass., and S. H. Yeaton, Palatka. Construction is to be started by February, 1891, and completed within a year. The supply will be from springs, by gravity. Estimated cost, $140,000. Population, 3,500.

Eustis, Fla.—The Eustis Water & Irrigation Company has been incorporated to furnish the city and suburbs with water for domestic use, fire protection and irrigation purposes. Capital stock, $15,000.

Franklin, Tenn.—P. E. Cox informs us that a water-works election will soon be held. Nothing has been decided upon as yet.

Murfreesboro, Tenn.—The following is from B. Selph, President City Illuminating Co.:

A company with a capital of $20,000 has been organized to supply water for domestic use. A stand-pipe will be used and the City Illuminating Co. will do the pumping, as it now has a contract with the city to pump water for fire protection.

Union City, Tenn.—J. Waddell has sent the following:

It is expected that construction will be started soon. The supply will be pumped from wells to a stand-pipe, and the town will own the works. Price Thomas is Secretary. Population, 4,000.

NORTH CENTRAL.

London, O.—According to press dispatches the city council recently passed an ordinance providing for the purchase of the company's works. A citizens' indignation meeting was called, and the following morning the order was repealed.

Toronto, O.—O. Y. Crawford, Secretary, informs us that the village is constructing works. All the contracts have been let. Water is to be pumped from the Ohio River to a reservoir.

Delphi, Ind.—The following is from C. A. O'Brien:

The town expects to build gravity works in 1890, taking the supply from a spring three miles from town. Bonds have not yet been sold. J. B. Fisher is chairman of the Water Board, and G. C. Morgan, Chicago, has been awarded the contract. Population, 3,000.

Rushville, Ind.—The following is from M. H. Downey:

A franchise has been granted J. P. Martin, Xenia, O., for works including pumps, stand pipe, 8 miles of 14 to 6-in. pipe, and 110 hydrants. The annual hydrant rental will be $4,500.

Petoskey, Mich.—G. S. Richmond, Superintendent, informs us that a new reservoir, duplex power pump and additional mains are projected.

Sault Ste. Marie, Mich.—The following is from O. Fowler, Mayor:

It is proposed to build a reservoir upon a hill to supply the high levels and Ft. Brady, and to have a water-power pumping plant. In case these improvements are made it is proposed to run the pumps with 96 lbs. pressure until the reservoir is filled, then shut off the reservoir connection and continue the pumping with the pressure at 30 lbs.

Elmhurst, Ill.—The Elmhurst Spring Water Co. has been granted an exclusive, 30-year franchise.

Keithsburg, Ill.—Geo. W. Sturtevant, Jr., Bushnell, informs us that contracts for works will not be let until April 1, 1891.

Mason City, Ill.—Geo. W. Sturtevant, Jr., engineer, of Bushnell, has sent the following:

The new city works will be put in operation Jan. 1. Cost, $12,000; population, 2,200.

Metropolis City, Ill.—J. H. Morris, Mayor, has sent the following:

The water-works question will be voted upon at the April election. The plan is to give a franchise to a home company. Supply, Ohio River; pumping to stand-pipe; population, 4,300.

NORTHWESTERN.

Algona, Ia.—The town proposes to dig the well still deeper, from 110 to 125 ft. The well was dug before the contracts for the construction of works were let, and therefore the failure of supply is not to be attributed to the contractors for the works, Harrison & Hawley, of St. Paul, as has been thought by some.

Butte, Mont.—It is reported that a new company has bought the franchise of the Hydraulic Mining Co. for $100,000, and will at once put in works costing about $2,000,000. Ray & Leonard, it is said, have charge of the engineering work. Frank Leonard, of the above firm is reported as having made, in substance, the following statements:

The work of construction will be done by Moffett, Hodgkins & Clarke, Syracuse, N. Y. Bonds have been floated through the agency of A. J. Coram, of the Butte & Boston Mining Co. The supply will be from the canal leading from Jerry Creek, 19 miles from Butte. It will be carried to the city through a 30-in. main.

SOUTHWESTERN

Kansas City, Mo.—It is reported that the water-works committee of the council will recommend that the city construct its own system of water-works, and will ask that the council require the mayor to call a special election to vote the bonds.

Helena, Ark.—W. M. Neal & Co. inform us that the town wishes water-works and is ready to receive propositions from responsible parties regarding the same.

Hubbard, Tex.—T. C. Morgan informs us that the Hubbard City Artesian Well & Water Co. are boring a well, and will put in works when water is secured.

Luling, Tex.—The following is from O. McGaffey, Jr., Secretary:

The Luling Water-Works Co. will have works in operation Feb. 1. Water is pumped from San Marcos River to a stand-pipe. Population, 2,000.

McGregor, Tex.—The following is from W. L. Blallock, President:

The McGregor Artesian Water Co. will soon begin to sink an artesian well with his own machinery. When water is found a stand-pipe and distribution will be put in. Population, about 1,500.

Oklahoma City, Ind. T.—The franchise noted last week was granted to W. A. Calhoun and J. H. Wheeler. In addition to what has been previously stated, it provides for two 1,000,000-gall. pumping engines, a stone or brick pump-house, and the purchase of the works by the city any time after 10 years. T. W. Upshaw is City Clerk.

Ridgway, Col.—A contract for putting in mains has been awarded to Gordon Kimball, of Ouray. Steel pipe will be used. Water will be brought from the foot of Mt. Sneffler to a lake or reservoir on the mesa above the town, from which it will be piped.

PACIFIC

Portland, Ore.—A reservoir is projected at the head of Jefferson St., to be used for low service when the supply from Bull Run is brought in and the new 40,000,000-gall. reservoir in the park completed. A high service pumping plant is also projected to be located at the Jefferson St. reservoir.

Brigham City, Utah.—M. L. Snow, Editor of the *Bugler*, has sent the following:

A supply main from the Box Elder Cañon is under consideration. Works are badly needed, and the prospects for construction in the spring are fair but not flattering.

CANADA.

Springfield, N. S.—The following is from Daniel McNeod, Town Clerk:

Proposals will be received until Jan. 20 for the construction of water-works in accordance with specifications on file in the office of the Town Clerk. Water will be pumped from a small river two miles distant. Construction will be started May 1, and the works will be in operation Dec. 31, 1891. A. D. Ferguson is Chairman of the Water Board, and A. E. Fraser is Mayor.

Amherstburg, Ont.—The following is from J. H. C. Leggatt, Town Clerk:

The town intends to float water bonds very soon, and hopes to let contracts for works in about three months. The supply will be pumped from the Detroit River to a tank. Estimated cost, $27,000. John Galt, Toronto, is Engineer.

ARTESIAN WELLS.

Castalia, S. Dak.—K. O. Hammer struck water at 878 ft. in a well west of the town. The well will be sunk deeper. It is stated that this is the first flowing well in Charles Mix Co., and that other wells will be sunk.

SEWERAGE AND MUNICIPAL.

Sewers.—*Woburn, Mass.*—The State Board of Health in considering the question of an independent system of sewerage for Woburn, investigated a scheme by which the sewage was to be collected on the easterly side of Horn Pond, and pumped through a force main about 2 miles long, to a level tract of gravelly land north of Montvale. The estimated cost of adopting this scheme would be about that of uniting with the proposed metropolitan system.

Pittsburg, Pa.—The 33d St. sewer has been completed by Evan Jones, the contractor. The work was commenced two years ago, and has cost $250 000. It is a 24-in. pipe at the upper end, and 8 ft. diam where it discharges into the Allegheny River. It drains an area of 1,800 acres, and is one of the trunk sewers contemplated for carrying off the drainage of the East End. Ordinances have been passed for the construction of several pipe sewers.

Washington, D. C.—The District Appropriation bill includes the following for sewer work: Cleaning and repairing, $43,000; replacing obstructed sewers, $25,000; main and pipe sewers, $119,000; suburban sewers, $58,390.

Wilmington, N. C.—Mr. Rudolph Hering has recently made an examination of the city in connection with the proposed sewerage system. To the sanitary committee he expressed the opinion that there would be no detriment to the health of the city to have a system of sewerage emptying into the Cape Fear river at the foot of the several streets running east and west, for the reason that the great volume of water and the tide twice a day would be sufficient to prevent the danger, even for many years to come when the population is several times larger than at present. The committee has appropriated $1,500 for a survey for a sewerage system. Mr. J. C. Chase is city engineer.

Cordele, Ga.—The city has voted $14,000 in 6 per cent. bonds for a sewerage system. Work has not been commenced. Information may be obtained from Mr. R. C. Harris, chairmen of the sewerage committee.

Montgomery, Ala.—A sewer ordinance has been passed by the city council regulating the constructing of sewers and sewer connections. An ordinance regulating the plumbing has also been passed. The sewer work is put under the supervision of the city engineer.

Atlanta, Ga.—Mr. Rudolph Hering, of New York, has presented his report on the sewerage system to Mr. Haas, chairman of the sewer committee.

San Rafael, Cal.—Mr. Geo. M. Dodge, engineer, writes us that the outfall is to be changed to empty direct into the Bay of San Francisco, either by a pumping system, as recommended by him, or some other system. There are about 15 miles of 6 to 16-in. iron stone pipe. The present outfall is into a creek.

Streets.—*Washington, D. C.*—The District Appropriation bill includes the following items for street work: Repairs to streets and alleys, $55,000; repair of county roads, $30,000; granite block paving on Brightwood Ave., $15,000; asphalt paving on Fourteenth St., $15,000; street work in Georgetown, $33,000; sprinkling, sweeping and cleaning streets, $115,000.

Columbus, O.—Several resolutions have been passed for street improvement, including paving with asphalt, stone block, Hayden block, Hallwood block or brick, and 5-in. Berea or Fulton stone curbing.

Key West, Fla.—Contracts for brick paving have been awarded to Miller & Nims, of Nebraska City, Neb., and Wm. G. Bear, of Kansas City, Mo.; the latter has sublet his contract to Walker & Hendricks, of Tampa, Fla. Mr. T. J. Ashe is City Engineer.

Gas.—*St. Louis, Mo.*—The suit by the city to compel the Laclede Gas Light Co. to supply gas at a cost not to exceed 90 or 95 cts. per 1,000 cu. ft., in accordance with a city ordinance, has been decided by the Supreme Court of Missouri in favor of the gas company.

Cleveland, O.—The Mayor is of opinion that the city should take steps to secure both the gas plants; the benefits which accrue to the public by the ownership of the water-works have already been proved.

ELECTRICAL.

Electric Light.—New plants or extensions are proposed at Ware, Mass.; Unionville, Conn., address M. J. Weeks; New Albany, Ind., address the New Albany Gas Light Co.

Warsaw, N. Y.—The Warsaw Electric Light & Power Co. has contracted with the village to furnish 25 arc lights of 2,000 c. p., at $65 per lamp-year on a 5 years' contract.

Haverstraw, N. Y.—The town will probably issue $20,000 of bonds for an electric light plant.

Philadelphia, Pa.—The following companies have received street and park lighting contracts: Brush Electric Light Co. at 40, 42½ and 50 cts. per night; Southern Electric Light Co. at 30 cts.; Philadelphia Electric Light Co. at 40 and 42½ cts.; Northern Electric Light Co., at 45 and 47 cts.; United States Electric Light Co. at 42½ cts.; Electric Power Co. at 32½ cts.; Wissahickon Electric Light Co. at 55 cts.; Germantown Electric Light Co. at 55 cts.; Frankford Electric Light Co. at 55 cts.; Suburban Electric Light Co. at 55 cts.; Powelton Electric Light Co. at 47 cts.

Four of the companies which received contracts have as yet no facilities for carrying their wires through the street, but under an ordinance of Councils they can erect poles for this purpose. These poles must be removed upon the expiration of contracts, and cannot be used for private business. The Electric Power Co. has no authority from City Councils yet to occupy the streets in any manner, although it has the contract for the central portion of the city. The Brush Co. was also a bidder for this territory, which it now serves, at 42½ cts. per lamp per night, but was underbid 10 cts.

Rockville, Md.—The Town Council has offered the Edison Company the right to establish a lighting plant in the village under the following conditions:

The town will contract to allow the exclusive use of the streets for the purpose stated for a period of 10 years, iron posts to be used on the main street and on the others wooden posts, neatly designed and painted; the town to take 10 arc lamps of 1,200 c. p. at $25 per lamp per year, reserving the right to take a greater number at the same price; the plant to be located within the corporation limits and subject to corporate taxation; the work to commence Feb. 1, and to be completed and in running order by July 1, 1891.

Falls Church, Va.—A meeting was recently held in this town to consider a plan for introducing electric lights. The subject was favorably debated, and a permanent organization, with E. A. Greenough as President, was formed.

New Albany, Ind.—The New Albany Heat, Light & Power Co. has received permission to place posts, towers and masts for power and light purposes. The company agrees to furnish arc lights to private consumers at $72 a year, and to the city at $65; incandescents, 16 c. p. lamps, at $1 per month or 1 ct. per hour.

New Companies.—Riverside, Ill., Edison Co.; capital stock, $40,000; incorporators, W. Hutchinson, L. Lusk, M. C. Myers. Du Quoin, Ill., Electric Light, Heat & Power Co.; capital stock, $10,000; incorporators, A. J. Blakeslee, W. H. Willis and E. T. Blakeslee.

CONTRACTING.

Dredging.—*New York, N. Y.*—The Department of Docks has awarded the contract for dredging for new pier, No. 14, North River, to the Atlantic Dredging Co., at 20 cts. and $1 per cu. yd. for mud and crib dredging respectively. The same company has the contract for dredging for the bulkhead wall at E. 102d St., Harlem River, at 45 cts. per cu. yd.

North and South Carolina.—Capt. W. H. Bixby, U. S. Engineer Office, Wilmington, N. C., has recommended the award of contracts as follows: Alabama Dredging & Jetty Co., Mobile, Ala.; at Beaufort harbor, N. C. 33⅓ cts. per cu. yd. in scows; waterway at Beaufort harbor, 25 cts. per cu. yd. in place; in New River, N. C., 49 cts. per cu. yd. in place, to be reduced 10 cts. per yd. if awarded two other works. Atlas Dredging Co., Wilmington, Del.; in Lockwood's Folly River, N. C., 20 cts. per cu. yd. in place, or 15 cts. if awarded work on Cape Fear River. P. Sanford Ross, Jersey City, N. J.; in Cape Fear River, 13¼ cts. per cu. yd.; in harbor at Georgetown, S. C., 29 cts. per cu. yd. in scows.

Breakwater.—*Gordon's Landing, Vt.*—The lowest bid received by Major M. B. Adams, U. S. Engineer Office, Burlington, Vt., for stone and extension of the breakwater was from E. H. French, of Fulton, N. Y.: 75 cts. per cu. yd. for rubble stone; $2.65 per cu. yd. for large stone; 16 cts. per lb. for ring bolts.

Piling, Stone, Mattresses.—*Wingaw Bay, S. C.*—Proposals were received Dec. 15, by Capt. W. H. Bixby, U. S. Engineer Office, Wilmington, N. C., and it was recommended that the contract be awarded to W. T. Gaynor, Fayettville, N. Y.; 100,000 ft. B. M. of sheet piling on shore and 900,000 ft. seaward, $45 and $53 per 1,000 ft. respectively; 300 cu. yds. oyster shells on shore and 3,000 seaward, $1.30 per cu. yd.; 1,000 tons of small stone on shore and 30,000 tons seaward, $2.75 and $2.50 per ton; 2,000 tons of large stone on shore and 6,000 tons seaward, $3 and $2.90 per ton; 50,000 sq. yds. of mattresses in work, 79 cts. per sq. yd. Total, $192,640.

Curbing.—*Washington, D. C.*—The District Commissioners have received the following proposals for 669 ft. of 6 × 20 in. granite circular curb: Brandywine Granite Co., $1.50 per ft.; Geo. Pierce, $1.50; Acker & Co., $1.79; John Booth, $1.79.

Stone.—*New York, N. Y.*—The contract for pier No. 14, North River, has been awarded by the Department of Docks to John Gillies; the contract price for rip-rap stone is 65 cts. per cu. yd.

PROPOSALS OPEN.

Sewers.—*Cincinnati, O.*—Sewers and drains. T. G. Smith, President Board of City Affairs, Jan. 3.

Newark, N. J.—Manholes, basins, 10 and 12-in. pipe. John Hunkele, Street Commissioner. Dec. 20.

Street Work.—*New York, N. Y.*—Crosswalks, granite block paving, etc. Department of Public Works, 31 Chambers St. Dec. 31.

Newark, N. J.—Trap rock block paving. John Hunkele, Street Commissioner. Jan. 2.

Cincinnati, O.—Grading, curbing, cro sings, guttering macadamizing, etc. T. G. Smith, President, Board of City Affairs. Jan. 17.

Dredging.—*Vicksburg, Miss.*—In the harbor. Capt. S. W. Roessler, U. S. Engineer Office, Memphis, Tenn. Jan. 11.

Brooklyn, N. Y.—The slip at foot of Hudson Ave. J. P. Adams, Commissioner of City Works. Dec. 30.

Rock and Brush.—Furnishing during season of 1891, 19,000 cu yds. of rock and 11,000 cu. yds. of brush, at Louisiana, Mo.; 5,000 cu. yds. of rock and 2,000 cu. yds. of brush, at Hannibal, Mo.; 34,000 cu. yds. of rock and 19,000 cu. yds. of brush, at Quincy, Ill. Major E. H. Ruffner, U. S. Engineer Office, Quincy, Ill. Jan. 8.

Building.—*Denver, Col.*—U. S. court house and post office. J. H. Windrim, Supervising Architect, Treasury Department, Washington, D. C. Jan. 6.

Bridge.—*New York, N. Y.*—Superstructure of a foot bridge over the N. Y. C. & H. R. R. and the N. Y. & N. R. R. near the Washington Bridge. Harlem River Bridge Commission, 1 Broadway. Jan. 7.

Harbor Work.—*Philadelphia, Pa.*—Dredging and removing wharves for improving the harbor. Major C. W. Raymond, U. S. Engineer Office. Feb. 12.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Baldwin Locomotive Works, of Philadelphia, Pa., have an order for 4 engines for the Wheeling Bridge & Terminal Ry. Co.; they have also an order for mogul engines for the Chicago & Northwestern. The Brooks Locomotive Works, of Dunkirk, N. Y., have recently completed several engines for the Northern Pacific Terminal Co., and for the Illinois Central. The Rhode Island Locomotive Works, of Providence, R. I., are building 10 eight-wheel engines, with cylinders 18 × 24 ins., for the New York, New Haven & Hartford. The Manchester Locomotive Works, of Manchester, N. H., have built a 10-wheel freight engine for the New York, Providence & Boston.

Cars.—The Barney & Smith Mfg. Co., of Dayton, O., is building some parlor cars for the Atchison, Topeka & Santa Fé R. R. McKee, Fuller & Co., of Catasauqua, Pa., are building 1,000 coal cars for the Lehigh Valley. The Pullman Palace Car Co., of Chicago, Ill., is building 50 standard gauge passenger cars for the Denver & Rio Grande. The Boston & Maine will shortly give out contracts for 50 passenger cars. Patterson & Corbin, of St. Catharines, Ont., are building 12 cars for the Ottawa electric street railway. The Westinghouse Electric & Mfg. Co. has an order for 20 electric cars for the Citizens' Traction Co., of Pittsburg, Pa. The Indianapolis Car Works, at Indianapolis, Ind., have been sold to a syndicate of creditors represented by E. Pollak, of Cincinnati, O., for $52,500. It is reported that a company has been organized to build extensive car works at Milwaukee, Wis.

Steam Road Roller.—The city of Halifax, N. S., has purchased an Aveling & Porter steam roller of 15 tons, and a mounted stone crusher with rotary screens.

The Kenwood Bridge Co. has put up a new plant at Grand Crossing, Ill., on the line of the Pittsburg, Fort Wayne & Chicago R. R.

Pile Coating.—The Excelsior Pile Coating Co. will establish a plant at Seattle, Wash., for treating piles with a composition of asphalt, etc., invented by F. E. Lampert and A. S. Levake. The piles are dipped in a boiling solution.

Signal.—A railway signal has been invented consisting of two disks of glass, placed about ¼ in. apart and set in a frame. By exhausting the air from between the plates a red liquid is drawn up into this space, showing a danger signal.

New Companies.—Whitehill Engine & Pictet Ice Machine Co., of Newburg, N. Y.; President, Robt. Whitehill, Vice-President, Wm. C. Dornin, of New York; capital stock, $500,000. Burnap Automatic Telephone Exchange Co., of Chicago, Ill., incorporators, C. E. Burnap, A. W. Brewerton and C. F. Congleton; capital stock, $4,000,000. McKeesport Construction Co., of McKeesport, Pa., for paving, macadamizing, etc.; directors, J. B. Shale, W. O. Bryson and W. E. Hartman; capital stock, $50,000. Hattiesburg Machinery & Car Mfg. Co., of Hattiesburg, Miss.; incorporators, F. E. Colboth, G. E. Kemper and T. J. George. Drexel Car Coupler Co., of Chicago, Ill.; incorporators, Wm. A. Alexander, A. C. McCord, D. W. McCord; capital stock, $600,000. Mexican Harbor Improvement Co., of Chicago, Ill.; incorporators, I. S. Baker, A. F. Deane, L. C. Twombley; capital stock, $1,000,000. Gennett Air Brake Co., of Chicago, Ill.; incorporators, David Wallace, Phillip Opper and I. Newberger; capital stock, $800,000.

Metal Market Prices.—*Rails.*—New York: $28; old rails, $22 for iron and $20 for steel. Chicago: $31 to $31.50; old rails, $23 50 for iron and $17 for steel. Pittsburg: $29 to $29.50; old rails, $26 to $29 for iron, and $17 to $18 for steel.

Foundry Pig Iron.—New York: $14.50 to $17. Chicago: $15 to $16.25. Pittsburg: $15.25 to $17.

Track Materials.—New York: steel angle bars, $1.70 to $1.75; spikes, $1.95 to $2; track bolts, 2.7 to 2.8 cts. with square, and 3.10 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.95 to 2.05 cts. for iron, 2 to 2.1 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.9 with square, and 3 cts. with hexagon nuts. Chicago: splice bars, 2.05 to 2.1 cts. for iron and 2.15 to 2.20 for steel; spikes, 2.25 cts.; track bolts, 3.1 cts. with hexagon nuts.

Pipe.—Cast iron, $27 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—New York, 4.1 to 4.15 cts. Chicago, 4.50 cts. St. Louis, 4.45 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles 2.15 to 2.30 cts.; tees, 2.65 to 2.75 cts.; sheared iron plates, 2.15 to 2.25 cts.; steel plates, 2.35 to 2.50 for tank, 2.6 to 2.7 cts. for shell, 2.85 to 3 cts. for flange, 3.75 to 4.25 cts. for firebox. Chicago: beams, 3 cts.; angles, 2.35 to 2.4 cts.; tees, 2.9 to 3 cts.; universal plates, 2.45 to 2.5 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.25 cts.; tees, 2.85 cts.; universal iron plates, 2.3 cts.; sheared steel bridge plates, 2.55 cts.; refined bars, 1.9 to 2 cts.; steel plates, 2.35 cts. for tank, 2.75 cts. for shell, 2.95 cts. for flange, 4 to 4.25 cts. for firebox.

Proposals for Sewers.

Sealed Proposals will be received by the Mayor and Board of Aldermen of the city of Winston, N. C., at the Mayor's office of said city until 2 o'clock P. M. of Friday, Jan. 2, 1891, for constructing a part of the proposed system of pipe sewers for said city.

Copies of the general plans and specifications, forms of proposals and instructions to contractors, and any information relative thereto may be obtained from the Chairman or Engineer of the Sewerage Committee.

The Committee reserves the right to reject any or all bids. J. M. ALLSPAUGH,
Chairman Sewerage Committee.
J. L. LUDLOW, Engineer. 49-4t

Raising Highway Bridge.

HAWKINSVILLE, Ga., Nov. 26, 1890.

Sealed proposals, in duplicate, will be received at the office of the County Commissioners of Pulaski County until 12 o'clock M. on Tuesday, the 27th day of January, 1891, for raising the highway bridge across the Ocmulgee River, at Hawkinsville. For all necessary information apply to D. G. FLEMING, Clerk of said Board of Commissioners, at Hawkinsville, Ga. 49-3t

Toronto Street Railway.

Sealed tenders addressed to the undersigned will be received by registered letter at the office of the City Clerk, Toronto, Can., up to noon on the 15th day of January, 1891, for the purchase or lease of the street railway tracks in the city of Toronto, with or without real estate, buildings, rolling stock and all material used in connection with the said railway, together with the exclusive right of operating the said railway on the streets of the city of Toronto. For further particulars and conditions of sale, apply after Dec. 1, 1890, to W. T. JENNINGS, City Engineer, Toronto, Can.

MILES VOKES,
Chairman Street Railway Committee.
TORONTO, Can., Nov. 19, 1890. 48—

To Sewer Contractors.

DEPARTMENT OF STREETS AND SEWERS,
OFFICE OF SUPERINTENDENT,
Room 8, City Hall,
PATERSON, N. J., Dec. 24, 1890.

Sealed proposals will be received by the Department of Streets and Sewers of the city of Paterson, N. J., until Tuesday evening, Dec. 30, 1890, at 8 o'clock, for the building of a sewer, with all the necessary manholes, basins, etc., in 10th Ave., East 27th St., and 11th Ave. (about 2,000 ft. of 48-in., 1,500 ft of 36-in. and 500 ft. of 30-in. brick sewer); time allowed to build, 200 days. Plans can be seen and specifications and blank proposals obtained at the office of the superintendent. Each proposal to be accompanied with a bond in the amount specified, conditioned that the parties receiving the contract will enter into bonds to double the amount of the contract for the faithful performance of the same. Each proposal to state in separate items the price of rock excavation, concrete, timber, etc., according to the blank proposals. The department reserves the right to reject any or all bids should they deem it to the interest of the city so to do.

THOMAS McLEAN,
Superintendent of Streets and Sewers.
52-1t

Canada.

THE WATER POWER COMPANY Building, with about 250 HORSE POWER presently occupied by the Edison General Manufacturing Company, at SHERBROOKE, Province of QUEBEC, is offered for sale or lease with possession on May 1, next. To UNITED STATES MANUFACTURERS desirous of establishing a a branch establishment in Canada, the premises and power now offered furnish unrivaled advantages, as Sherbrooke, besides being upon the main lines of the Grand Trunk and Canadian Pacific Railways and the northern terminus of the Boston & Maine and Connecticut River railways, is the center of the copper, sulphur, asbestos, slate and lime industries of the Province of Quebec.

Address E. F. WATERHOUSE, Sec.-Treas.

N. B.—The city of Sherbrooke grants EXEMPTION FROM municipal TAXATION upon liberal conditions to new manufacturing enterprises.

SHERBROOKE, P. Q., Canada, Dec. 19, 1890.
52-

S. E. NOBLE, Prest. JNO. E. WARE, Secy. and Treas. R. F. CARTER, Supt.

The Anniston Pipe Works,

MANUFACTURERS OF

CAST IRON WATER AND GAS PIPE,

ANNISTON, - - - - ALA.

Especially adapted for the Elevation of Clear, Gritty, Thick, or Acidulous Liquids, Quickly, Cheaply and Efficiently.

PATENTED U. S. AND CANADA.

THE NEW PULSOMETER STEAM PUMP.

without Engine, Machinery, Oil, Expensive Power, Skilled Labor, or Material Wear. Send for Illustrated Catalogue.

PULSOMETER STEAM PUMP CO., 120 Liberty St., New York.

MONTAGUE & CO.,

MANUFACTURERS

FIRE BRICK, SEWER PIPE,

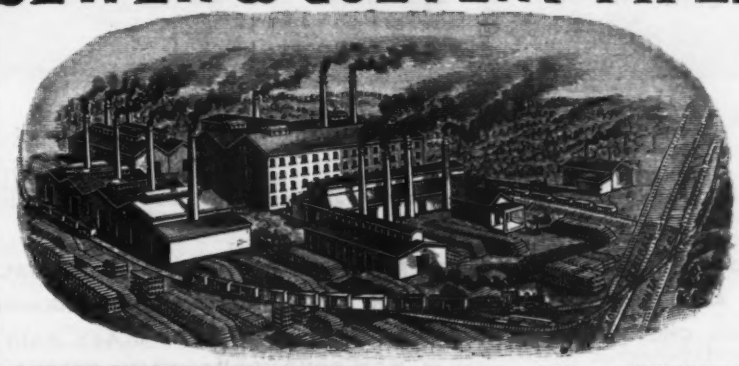
DOUBLE STRENGTH

RAILROAD CULVERT PIPE,

With long sockets, in two and one-half foot lengths.

CHATTANOOGA, - - - TENN.

DOUBLE STRENGTH SEWER & CULVERT PIPE.



MONMOUTH MINING & MFG. CO., MONMOUTH, ILL.

PROPOSALS FOR RIP-RAP GRANITE—Engineer Office, U. S. Army, Newport, R. I., Dec. 5, 1890.—Sealed proposals, in triplicate, for furnishing and placing Rip-Rap Granite in the eastern jetty at Nantucket, Mass.; the north wall of the inner harbor at Block Island, R. I.; the Breakwater at Point Judith, R. I., and the Eastern Breakwater at Stonington, Conn., will be received at this office until 12 o'clock, noon, on Monday the fifth day of January, 1891, and then opened. The attention of bidders is invited to the Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. The United States reserves the right to reject any or all proposals and to waive any informalities. Full information will be furnished on application. W. R. LIVERMORE, Major of Engineers.
49-4t.

PROPOSALS FOR STONE JETTY AT THE mouth of the Saco River, Maine. U. S. Engineer Office, Portland, Me., Dec. 13, 1890. Sealed proposals, in triplicate, for construction of stone jetty at the mouth of Saco River, Me., will be received at this office, 337 Congress St., until 2 P. M. of Wednesday, Dec. 31, 1890, and then opened. Attention is invited to Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. All necessary information furnished by JARED A. SMITH, Lieut. Col., Corps of Engineers, U. S. Army. 51-2t

PROPOSALS FOR DREDGING IN BELlamy River, New Hampshire. United States Engineer Office, Portland, Me., Dec. 8, 1890. Sealed proposals in triplicate for dredging in Bellamy River, New Hampshire, will be received at this office until 3 P. M. of Tuesday, Dec. 30, 1890, and then opened. Attention is invited to acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, vol. 23, page 332, and vol. 24, page 414, Statutes at Large. All necessary information furnished by JARED A. SMITH, Lieut. Col. Corps of Engineers, U. S. Army.
50-3t

Long Leaf Yellow Pine.

For bridges, trestles, and car building. Mills in belt of the finest South Georgia yellow pine timber. Orders promptly filled. Address, C. J. HADEN,
Secretary and General Manager, Hoech Lumber Co., Clark Lumber Co.
Atlanta, Ga.

Horizontal Pumping Engines.

CINCINNATI, O., Dec. 10, 1890.

Sealed proposals will be received at the office of the Board of City Affairs until 12 o'clock noon of Wednesday, Jan. 14, A. D. 1891, for one and two Horizontal Pumping Engines, as follows:

For one compound condensing engine having a capacity of six million gallons in twenty-four hours, with a steam pressure of 110 pounds and a water pressure of 145 pounds. This engine to be delivered as a perfect low duty, but so arranged as hereafter to be made by additions to show a duty of one hundred million foot-pounds.

Bidders will state in their proposal the cost of this engine, delivered and erected in Cincinnati, O., as also the additional cost of the proposed additions for full duty, if ordered within twelve months of the date of this contract.

Proposals will also name the cost of one additional engine of same size and full high duty, with the right to order same within one year from date of contracting for the first engine.

Bidders will furnish full drawings and specifications with their proposals and also state their guarantee as to time of delivery and duty to be shown by test.

Information will be furnished by Willis P. Tharp, Superintendent and Engineer Cincinnati Water-Works.

A certified check in favor of the Board of City Affairs to the amount of $3,000 will be required in lieu of bidder's bond, to be forfeited for non-acceptance of award; otherwise, to be returned.

The Board of City Affairs reserves the right to reject any and all bids.

By order of the Board.

THOMAS G. SMITH,
President Board of City Affairs.

Attest:
D. W. BROWN, Clerk. 51-4t

Royal Siamese State Railways.

NOTICE.

It is hereby notified for general information that TENDERS in the form of a schedule of rates for each class of work required will shortly be invited for the construction of the ROYAL SIAMESE STATE RAILWAYS from the capital of Bangkok to Bang-Pa-In, Ayuthia, Saraburi, and Korat, 268 km.

The works will be let out either in sections of from 70 to 100 km. or given to a general contractor.

The tenders will include all works and supplies necessary for completing the said railways, exclusive of the supply of permanent way and telegraph material, rolling stock, machinery and furniture, which will be provided by the Royal Siamese Railway Administration and delivered, when required, to the Contractors in the depots at Bangkok and Ayuthia.

In every other instance, the contractors are expected to supply themselves with all the necessary plant, such as tools, small railways for earth and other provisory transport, excavators, pumping and ramming machinery, etc., etc.

Those intending to tender are advised to personally examine the line and the plans, which may be seen from the 1st January, 1891, at the office of the Royal Railway Department in Bangkok.

The following figures represent approximately the amount of the principal works to be tendered for:—

Earthwork (stiff clay), 4 millions of cu. m.
Cutting in hard limestone rock, 200,000, cu. m
Retaining walls (rough rubble), 5,000 cu. m.
Masonry in abutments, 50,000 cu. m.
Timber for bridges, 8,000 cu. m.
Fourteen stations with wooden buildings, 11 of which are very small, etc., etc.
Gauge, 1.435 m. = 4 ft. 8½ in., English.
Weight of rails, 30 kg. per meter.
Sleepers, teak or red wood (maideng) 250 × 15 × 20 cm. = 8 ft. × 6 in. × 8 in., English.

The line runs for about 75 kilometers (km.) through the low alluvial plain of the Meinam, on an embankment from 2 to 4 m. high and is easily accessible by water.

From km. 75 to 136 the railway is accessible by land and runs nearly level with the ground.

From km. 136 to km. 180 the line is only accessible by pack animals (bullocks), and that only during the dry season (December to July).

At km. 136 the line enters into valleys along which it ascends to the table-land of Korat (300 m. above sea level, summit 394 m.) with gradients of 15 per mile, and curves of 180 m. radius through a splendid forest affording any quantity of wood which may be cut for the construction free of charge.

At km. 180 the table-land is ascended, and from there to Korat the line is again without any difficulties, with easy gradients and curves nearly level with the ground.

As regards the climate, it may be mentioned that in January the temperature in the mountains goes down to 50° Fahr. during the night.

Time of construction: Two years from date of agreement for the Bangkok-Ayuthia section; four to five years up to Korat.

By order of the Minister of Public Works.

K. BETHGE,
DIRECTOR GENERAL OF RAILWAYS.
49-4t

Notice to Contractors.

Sealed tenders will be received up to 6 o'clock P. M. on the 8th of January, 1891, for constructing and laying a 24-in. riveted steel suction pipe in Kingston (Ont.) harbor.

Tenders to be addressed to the Chairman of the Committee on Water-Works, Kingston, Ont., and endorsed Tender for Suction Pipe.

A copy of the specifications and full particulars can be obtained on application to the undersigned.

The lowest or any tender not necessarily accepted.

T. O. BOLGER,
City Engineer.
KINGSTON, Ont., Dec. 17, 1890. 51-2t

U. S. ENGINEER OFFICE, 905½ E. Main street, Richmond, Va., Nov. 25, 1890. Proposals for dredging in the James River, Va., near Richmond, and at Kingsland Reach, will be received until noon of Dec. 23, 1890, and then opened. The attention of bidders is invited to the Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, vol. 23, page 332, and vol. 24, page 414, Statutes at Large. All information can be had of the resident Engineer, Mr. C. P. E. Burgwyn. WM. P. CRAIGHILL, Colonel of Engineers, U. S. A. 50-3t

For other Proposals See Pages XIV and XXI.

NATIONAL PAINT WORKS

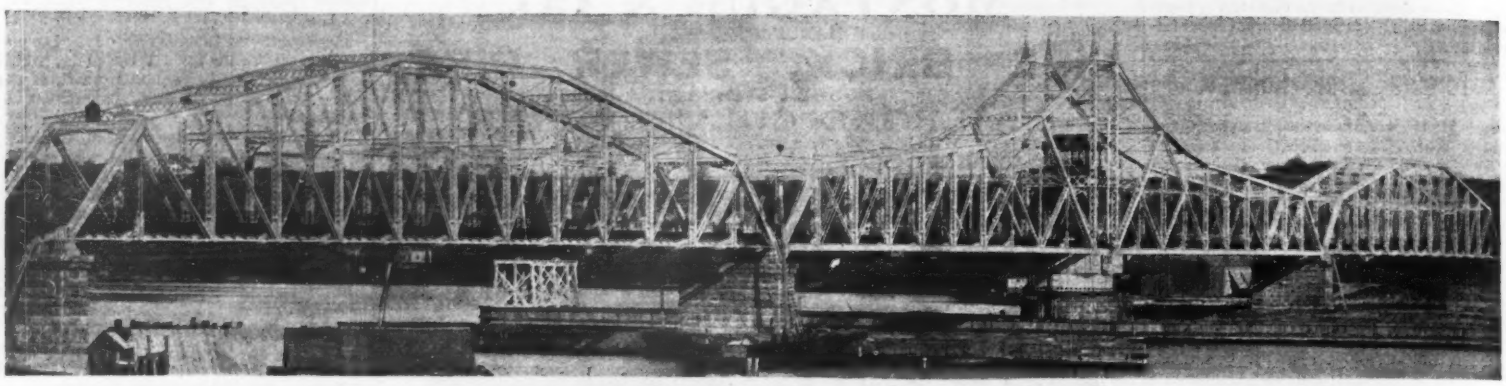
WILLIAMSPORT, PA.

— THE ONLY MANUFACTURERS OF —

ELLIOTT'S ASPHALTUM PAINTS

IN ALL COLORS. MIXED READY FOR USE.

The Recognized Standard for Quality. Sales in 1879, 1,000 Barrels. Sales in 1889, over 10,000 Barrels.



The Thames River Bridge at New London, Conn., Built by Union Bridge Co., Painted with our No. 31 and 58.

In the preparation of our paints we use only the very best Lead, Zinc, Minerals, Coloring Materials and Crude Asphaltum, ground in and thinned with PURE LINSEED OIL.

ARE NOT AFFECTED BY THE GASES AND ACIDS RESULTING FROM COMBUSTION OF COAL.
WORK FREELY AND EVENLY WITH A FINISH EQUAL TO THAT OF VARNISHED WORK.
ARE CHEAPER AND AS DURABLE AS ANY FIRST-CLASS PAINT IN THE MARKET.
A NON-CONDUCTOR OF HEAT AND WILL STAND 300 DEGREES.

Ten years' practical experience with our Paints has resulted in their use and adoption as the standard for quality by nearly all of the leading railroads of the country; Bridge Builders, Iron Works, Car Works, and corporation trade generally.

Are Unsurpassed for Depots, Freight Cars, Bridges (wood or iron), Tin or Iron Roofs, Water Tanks, Houses, Barns, Vessels, etc., etc.

To show the popularity of our goods, we mention a few of our customers and a few large structures painted with our Paint:

Central Viaduct, Cleveland, O.
N. Y. C. & St. L. R. R. Viaduct, Cleveland, O.
New C. O. R. R. Bridge, Cincinnati, O.
Poughkeepsie Bridge.
New London Drawbridge.
Denver Cable Road.
Cantilever Bridge, Niagara Falls.
Harvard Bridge, Boston, Mass.
U. S. Gov. Heavy Ordnance Works.

Union Bridge Co.
Phœnix Bridge Co.
Keystone Bridge Co.
Edge Moor Bridge Works.
Pencoyd Iron Works.
Passaic Rolling Mill Co.
Standard Oil Co.
New York Central & H. R. R. R. Co.

Boston & Albany R. R.
Boston & Maine R. R.
New York, New Haven & Hartford R. R.
Pennsylvania R. R.
Richmond & Danville R. R.
Atlantic Coast Line.
East Tenn., Va. & Georgia R. R.
Texas Pacific R. R.

Illinois Central R. R.
Chi. & Northwestern, R. R.
Chi., Bur. & Quincy R. R.
Louisville & Nashville R. R.
Ohio & Miss. R. R.
Col., H. V. & Tol. R. R.
Lake Shore & M. S. R. R.
Western N. Y. & Pa. R. R.

Samples, Price-Lists and References from those who have used and are now using these paints in your vicinity furnished on application.

SITUATIONS WANTED.

WANTED.—A position with engineering corps as transit observer or leveler, on preliminary or location, or as instrument man on maintenance of way. References. Address H., care Engineering News. 49-4t

WANTED.—Position on location, construction or maintenance of way. Fifteen years' experience, 37 years old, correct habits, graduate. Address C. E., 15, Engineering News. 49-4t

WANTED.—An engineer having charge of designing and superintending the ironwork for important fire-proof structures wishes to correspond with reliable parties to make a business combination, or would accept a salaried position for sufficient inducements. Is well acquainted with architects, engineers and contractors, and has had extended experience in estimating and soliciting contracts. RELIABLE, care Engineering News. 50-4t

WANTED.—A good transit or theodolite with seven inch circle, 30" or 20" graduation, to hire for a period of three months. Address with terms and particulars, A. D. WILSON, Deadwood, So. Dakota. 51-2t

WANTED.—A civil engineer (M. Am. Soc. C. E.) of 20 years' experience in the location and construction of railroads and other public works would like an engagement; has had large experience in Mexico, and would like to correspond with parties requiring the services of an engineer in Mexico, Central or South America. Address ENGINEER, care Engineering News. 51-3t

WANTED.—A young man desires a position as an assistant resident engineer or instrument man; good references as to habits and ability. Address K. K., Engineering News.

WANTED.—A young man wants work as transitman, levelman or draughtsman on railroad work in South America or Mexico; can give references. Address H. VAN ZANT, 305 East Fifteenth St., Minneapolis, Minn. 51-3t

WANTED.—By an engineer (graduate M. A. C., '78) with several years' experience in practical railroad work, a position upon survey, railroad construction or city work, South or West. J. F. HUNT, Sunderland, Mass. 51-4t

WANTED.—An experienced engineer on railroad construction and town site work desires a position; have had 10 years' experience and can show good references; have also been engaged in city electric railroad work; I have instruments. Address TRANSIT, care Engineering News. 51-6t

WANTED.—By an engineer, late acting engineer in a city of 20,000 population. Also accustomed to country work. Address H. WARD, care Thos. E. Jenkins, Advertising Agent W. M. R. R., Baltimore, Md. 52-1t

WANTED.—Employment by engineer, experienced in railroad location and construction. Age, 28; owns level; good references. At present located in Virginia. Address W. A. D., care Engineering News. 52-3t

WANTED.—A position as locating or division engineer. Thirteen years' experience on railroad work—11 in the United States, 2 in Mexico. Fair knowledge of Spanish. Address ROBERT BURGESS, 1224 Hebert St., St. Louis, Mo. 52-4t

WANTED.—Position by an engineer of 20 years' practical experience on location, construction, tunneling, foundations, and as superintendent of construction. Best of references. Address M. E., Engineering News office. 52-6t

SITUATIONS VACANT.

WANTED.—An engineer, 31, experienced in railroad location and construction, and having had charge of heavy work, as tunneling, heavy rockwork foundations, masonry and bridge erection, also of maintenance, desires a position. Best references. Address CIVIL ENGINEER, P. O. Box 568, Albuquerque, N. M. 50-4t

WANTED.—A topographical draughtsman. Must furnish references and sample of work. Address, stating salary wanted, F. N., care of Engineering News. 51-2t

WANTED.—A competent topographical engineer. Must furnish references and sample of work; must be good at figures. Address, stating salary wanted, F. N., care of Engineering News. 51-2t

MISCELLANEOUS.

WANTED.—We will send a copy of "Cross' Engineer's Field Book" in exchange for ENGINEERING NEWS of July 19, 1890. Address Engineering News.

WANTED.—To purchase vol. 8, bound or unbound, of ENGINEERING NEWS; state price wanted. Address, F. A. PECKHAM, Room 302, Opera House Block, Chicago, Ill. 51-?

"Why remain idle? Every day there are hundreds of positions to be filled. Only a few people advertise for help. Courage and perseverance will bring their merited reward."

Concrete Stone.

Tenders to furnish 22,000 cubic yards of concrete stone will be received at the office of the Washington & Georgetown R. R. Co., Washington, D. C., until noon of Dec. 31, 1890. The right is reserved to reject any or all bids. Specifications may be seen at the office of said company. HENRY HURT, President. 51-2t

ADVERTISE CONTRACT WORK IN ENGINEERING NEWS.

ADVERTISE "WANTS" IN Engineering News.

Hoosac Tunnel Route

FITCHBURG RAILROAD.

Short line between the East and West. Sleeping and drawing-room cars on all express trains.

J. R. WATSON, Gen. Pass. Agt., BOSTON, MASS.

The Great St. Clair Tunnel

JUST FINISHED.

WITH INGERSOLL-SERGEANT MACHINERY.

THE ST. CLAIR TUNNEL COMPANY.

CHIEF ENGINEER'S OFFICE,
HAMILTON, Ont., Oct. 2, 1890.

In reply to your inquiry as to the performance of the four 20" × 24" New Ingersoll-Sergeant Air Compressors furnished by you for the St. Clair Tunnel Co., I beg to say that it has been perfectly satisfactory. They have been thoroughly tested, as they have been continually at work night and day, Sundays included, for nearly six months.

Yours truly,

JOSEPH HOBSON,
Chief Engineer

INGERSOLL-SERGEANT ROCK DRILL CO.,
10 Park Place, New York.

INGERSOLL-SERGEANT ROCK DRILL COMPANY,

Manufacturers of the Celebrated Ingersoll and Sergeant Mining and Quarrying Machinery.

NOTICE.—Ingersoll-Sergeant Drills are manufactured only in New York City and Montreal, Can. This company is not represented by agent or otherwise in England.

10 PARK PLACE, NEW YORK.

FOR SALE.

One 12-in. × 18-in. "Morris County" Air Compressor, good.
One 15 H. P. Westinghouse Engine, good.
One 36-in. × 7-ft. Vertical Boiler, nearly new.
One 24-in. × 6-ft. Vertical Boiler, good.
Two 12 H. P. Special Vertical Submerged Flue Boilers.
One 24-in. × 36-in. Iron Hoisting Bucket.
One No. 6 Sturtervant Blower, new.
One Hand Power Hoist or Crab, new.
One Ribon & March Iron Swivel Dump Car, new.

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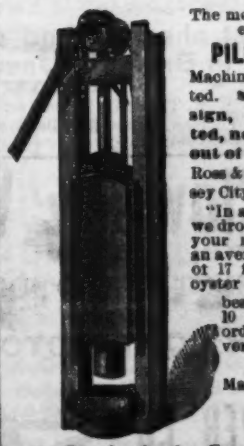

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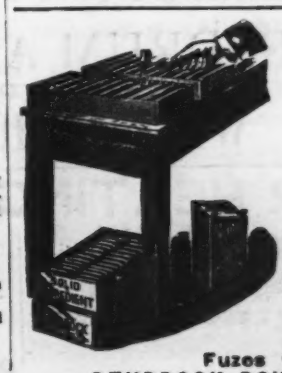

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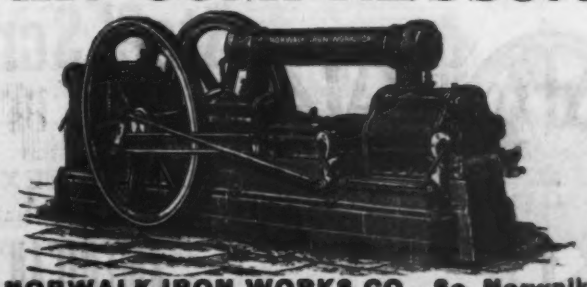

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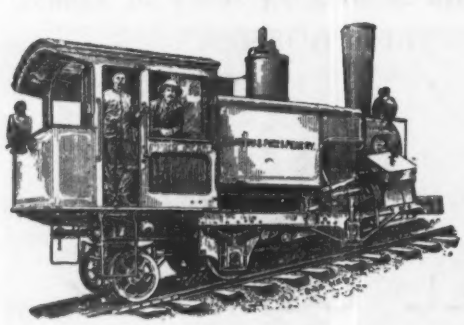

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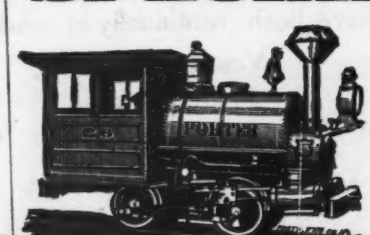

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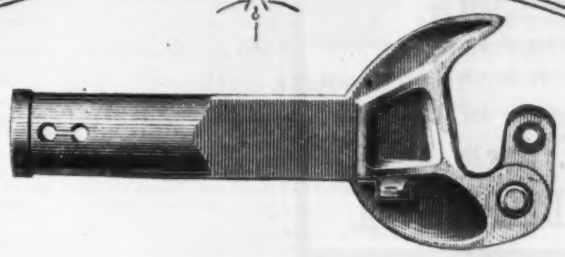

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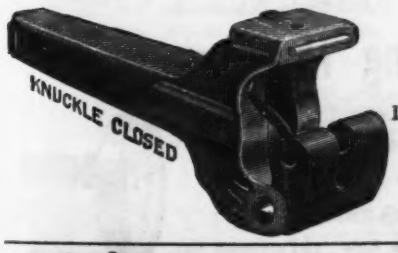

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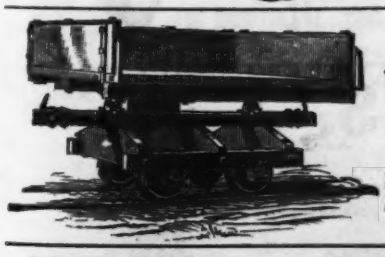

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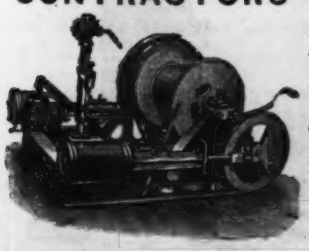

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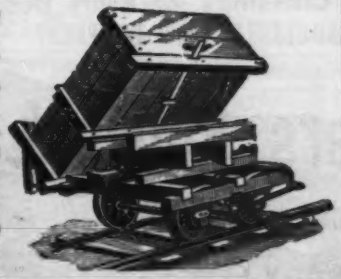

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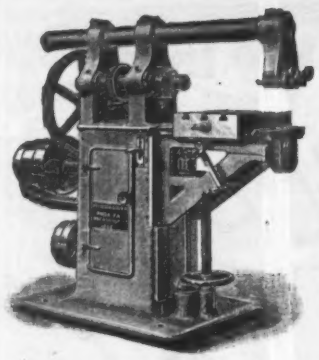

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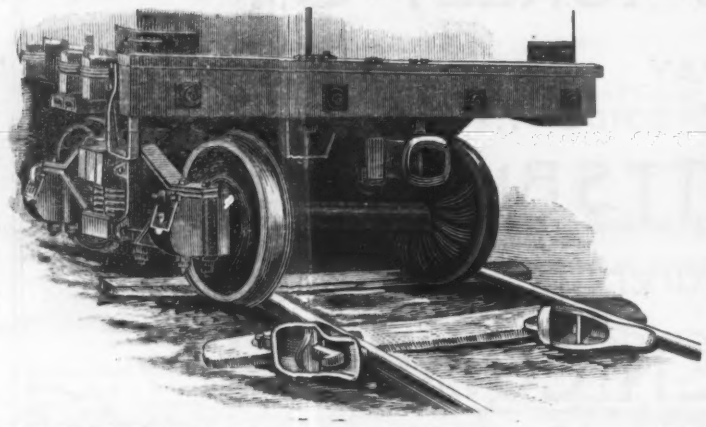

Weight, 160 Pounds. Price, $25.00 per Set.

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The Public is Respectfully Informed

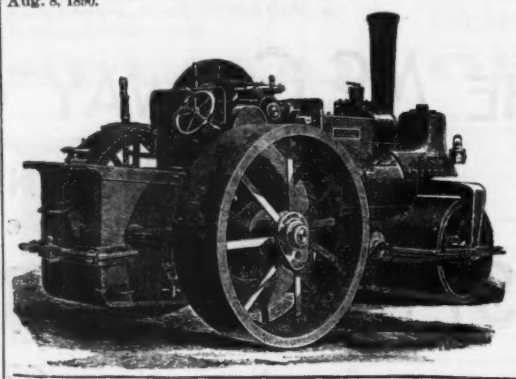
that a former advertisement in ENGINEERING NEWS relative to a trial between the Aveling & Porter and Harrisburg machines at Cambridge, Mass., on Aug. 5, 1890, was a tissue of misrepresentations.

During a week's work of the Harrisburg Roller several of the spokes of the rolling wheels were or became loose, the grate bars were twisted from the excessive blast of the double cylinders and the imitation double speed gear became loose and out of order. The engine was complicated and noisy and incomparably inferior to the Aveling & Porter simple single-cylinder engine.

Despite these breakdowns and faults, the Streets Committee voted (3 to 2) to buy the Harrisburg Roller, and the animus against "The English Roller" was so great with certain members of the committee that *two of them actually voted not to hear the representative of the Aveling & Porter machine in support of his own roller.* The two Aldermen of the committee (including the chairman) voted for the A. & P. Roller, and the three councilmen against it.

A Harrisburg Roller at Indianapolis, Ind., *after about six weeks' use,* has twisted its grate-bars, burned its baffle-plates, broken the large casting and pin which support the forward wheels, and otherwise has shown a serious amount of wear and tear! !!

"I cannot understand how any intelligent comparison can allow of anybody choosing the Harrisburg Roller to your's, but I suppose that the intelligent comparison is lacking and that some other influences prevail. —Col. John Y. Culyer, Mem. A. S. C. E., Civil Engineer and Landscape Architect New York City and Consulting Engineer Brooklyn Parks Commission, Aug. 8, 1890.



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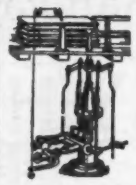

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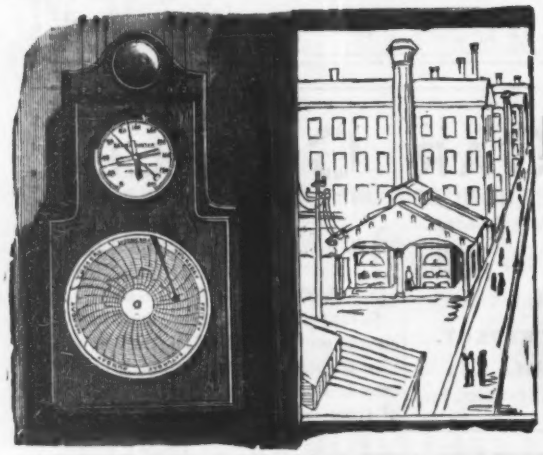

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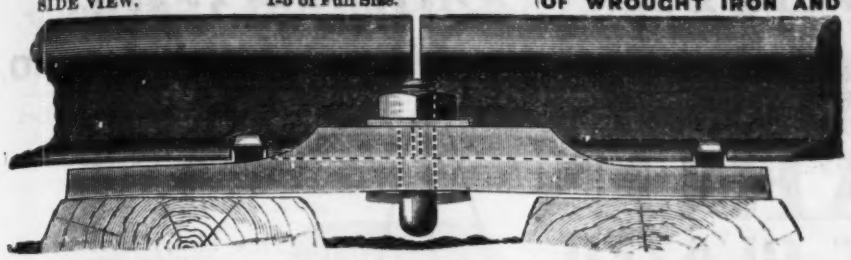

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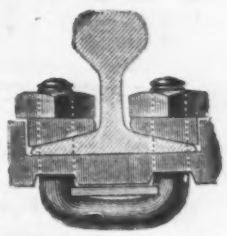

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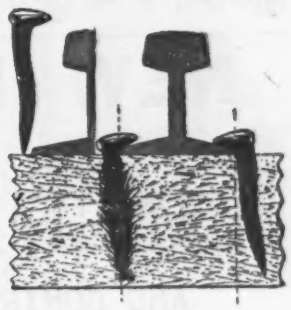

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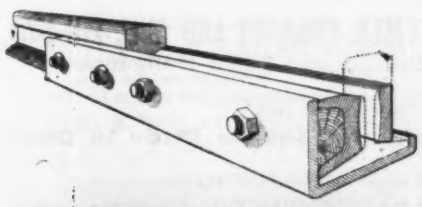

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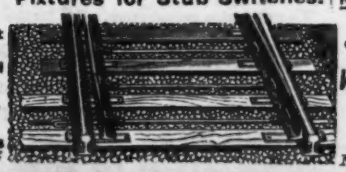

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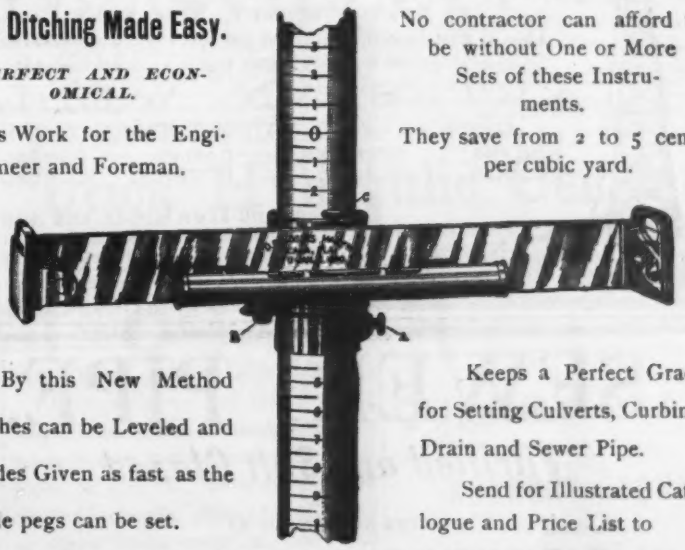

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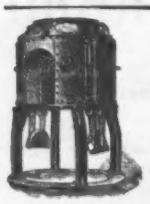

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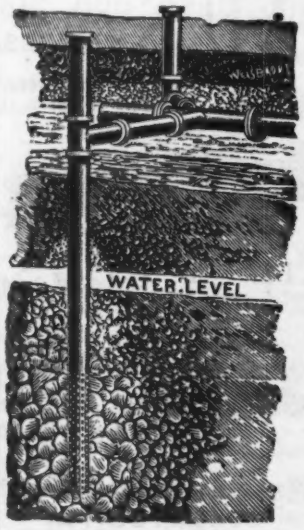

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THE ONLY
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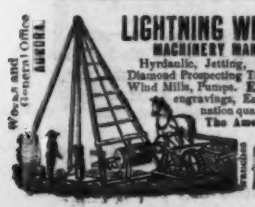

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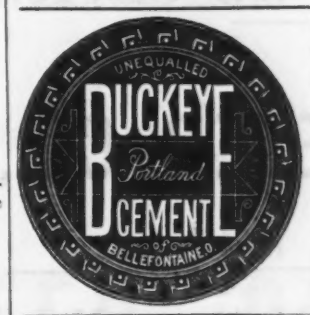

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DETROIT, July 17, 1890.

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GENTS: Received this A M. five 3 in. meters, also invoice of same.

We removed one of your 1 in. meters, No. 1765, it having been in service just two years. It registered 321,040 cu. ft. We tested it and found that it was *very nearly perfect*, and are very much pleased with the showing. Very respectfully yours, (Signed) T. R. PUTNAM.

No. 2. DETROIT, July 23, 1890.

The Thomson Meter Co.:

GENTLEMEN: Yesterday we received fifty ¾ in. and five 1½ in. meters. No invoice of ¾ in meters as yet.

We have now a good stock of meters on hand, and will not require any more until further orders.

Have no objection to the publishing of our test of your 1 in. meter. We are very much pleased with the "Thomson Meter," as they give us less trouble than any others we have in use.

The severe test of your ⅝ in. meter now being made by Mr. Brown, of Fitchburg, Mass., as mentioned in yours of the 19th inst., speaks well of the durability and positiveness of your meters. Hoping it will exceed your expectations, I remain, Yours respectfully,

(Signed) T. R. PUTNAM.

POSITIVELY THE BEST AND CHEAPEST.

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Shedd Water Meter
(BI-LOBE.)

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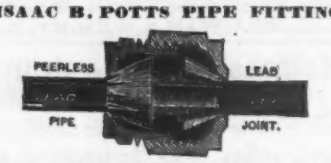
SAVE YOUR MONEY BY USING THE ISAAC B. POTTS PIPE FITTINGS.



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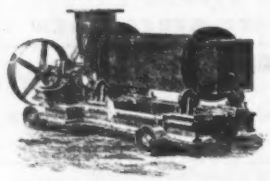

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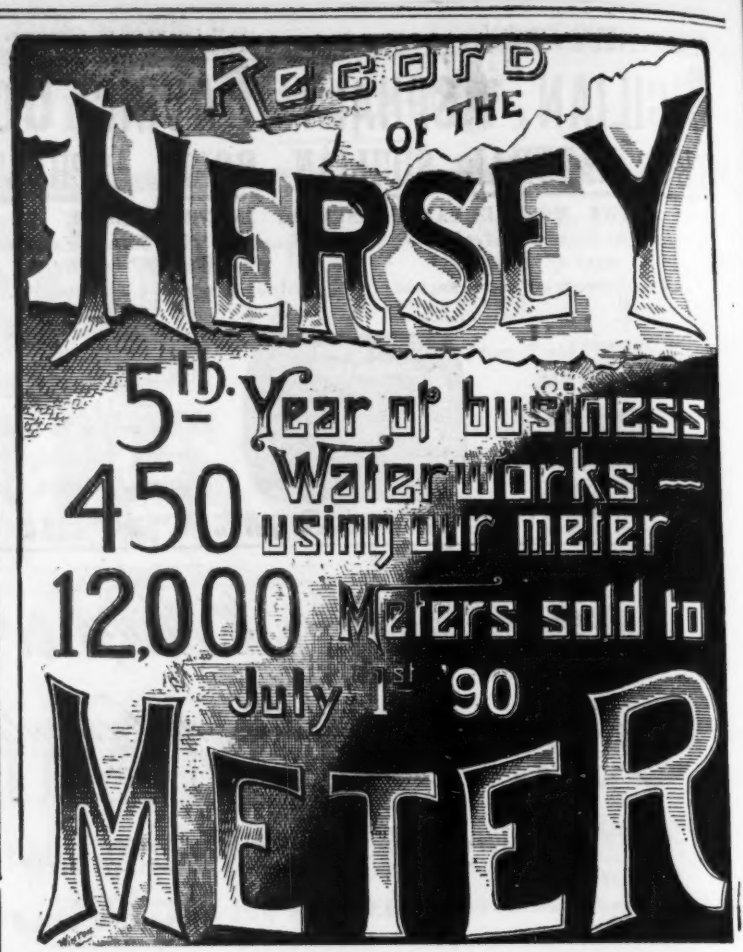

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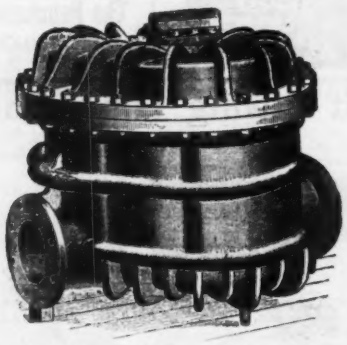

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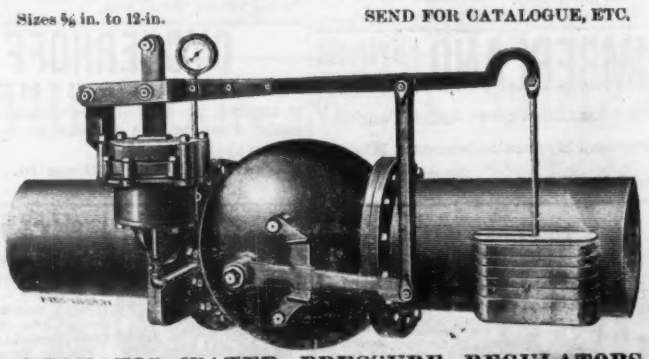

AUTOMATIC WATER PRESSURE REGULATORS.

We have never had one of these machines fail to do their work. Write for circular, etc,

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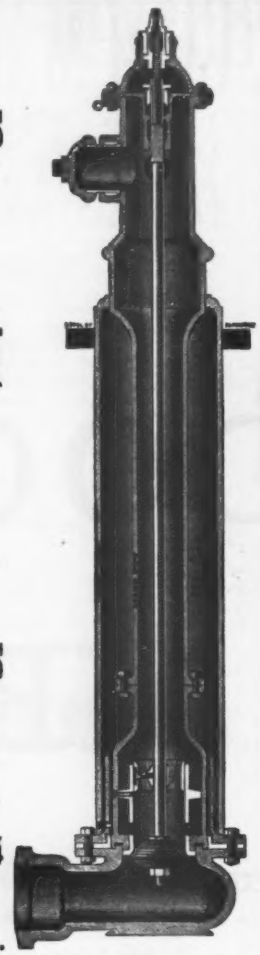

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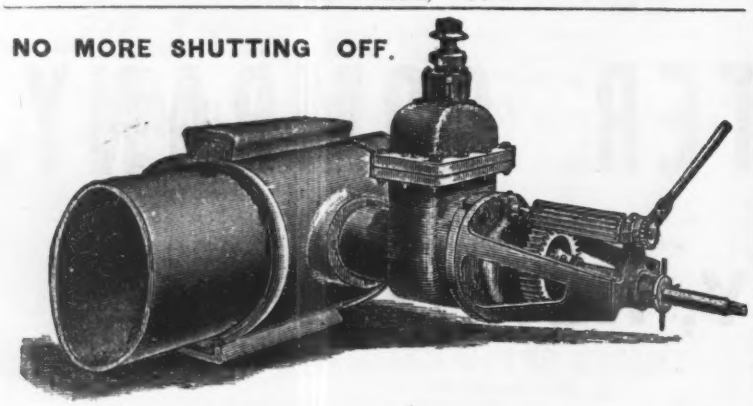

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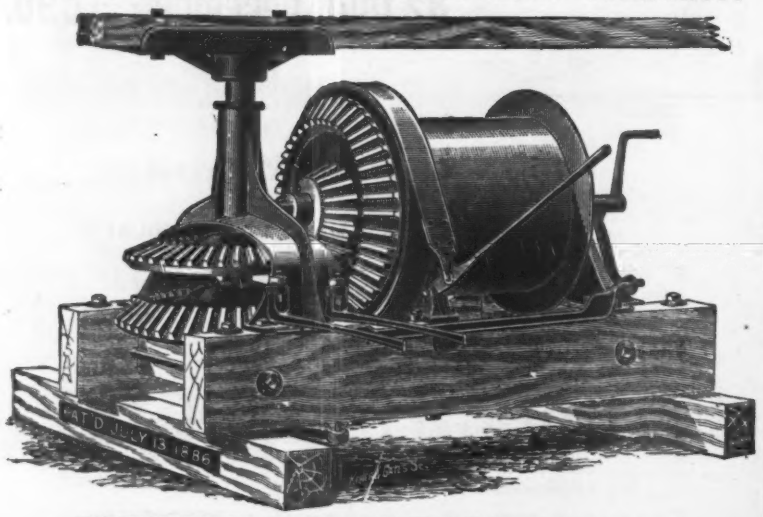

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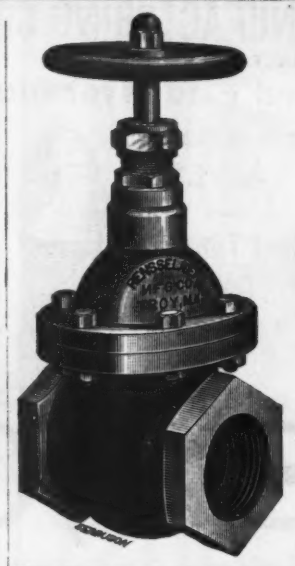
125 ERIE STREET, BUFFALO, N. Y. U. S. A.



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BRASS AND IRON
Gate Valves
FOR
WATER, GAS, STEAM AND OIL.

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Manufacturers of
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Dredging Contractors.

Most, if not all, late dredger patents, whether endless-chain or suction, depend for success on parts not covered by these patents, but fully covered by mine. I have suits pending against many of those, with more to follow. Parties who infringe my patents are seeking to sell their subordinate patents and infringing machines before judgment can be had. I caution all carefully to examine patents and to consult expert patent attorneys as to *scope* and *validity* before buying, using or building new machines, as I shall avail myself of all the resources of the law in protection of my rights.

A. B. BOWERS, Engineer.
Contractor for Dredging, Filling, Etc.
17 Cortlandt St., New York; 175 Dearborn St., Room 70, Chicago; Room 7, No. 137 Mont. St., San Francisco; 344 D St., N. W., Room 3 and 4, Washington, D. C.

Sealed Proposals

will be received by the Winston-Salem Land and Investment Co., of Winston, N. C., until Monday, Jan. 12, 1891, 2 o'clock P. M., for building an iron bridge or a combination bridge over Salem Creek 110 ft. long, with 40 ft. clear roadway. The right is reserved to reject any or all bids. For particulars address

J. L. LUDLOW,
52-2t Engineer.

Notice to Railroad Contractors.

Proposals are invited for the graduation and trestle work of the road from Fayetteville, N. C., to Rowland, 42 miles.

The road will be divided into nine (9) sections of about five (5) miles each.

Bids may be made for a section or sections or for the whole line.

The trestle work will be mainly of driven pile work. Bids for trestle work may be made distinct from or in connection with the graduation.

Plans and profiles and specifications can be seen at the office of the Wilmington & Weldon R. R. in Wilmington or at Fayetteville.

Bids will be opened and contracts awarded on Jan. 22, 1891.

Work to be completed on or before Aug. 1, 1891.

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IMPROVEMENT OF PHILADELPHIA HARBOR. U. S. Engineer Office, 1428 Arch Street, Philadelphia, Pa., December 12, 1890. Sealed proposals, in duplicate, will be received at this office until 11 A. M., Thursday, Feb. 12, 1891, and then opened, for dredging and removal of wharfing in Philadelphia Harbor. The attention of bidders is invited to the Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332 and Vol. 24, page 414, Statutes at Large. For all information apply to C. W. RAYMOND, Major of Engineers, U. S. A. 51-6t.

U. S. ENGINEER OFFICE, BURLINGTON, Vt., Dec. 22, 1890. Sealed proposals, in duplicate, addressed to the undersigned, will be received at this office until 11.30 A. M., Jan. 13, 1891, and then publicly opened, for blasting and removing 247 cu. yds. of rock, more or less, from two shoals between Sister Islands and Cross-over Light, Saint Lawrence River, N. Y. Attention is invited to the Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. Detailed information can be had on application. M. B. ADAMS, Major of Engineers. 52-1t 2-1t.

ENLARGEMENT OF BREAKWATER at Greenport, N. Y. Engineer Office, U. S. Army, Room H, 7 Army Building, 39 Whitehall street, New York, N. Y., Dec. 27, 1890. Sealed proposals, in triplicate, for enlargement of the breakwater at Greenport, N. Y., will be received at this office until twelve (12) o'clock, noon, on Tuesday, Jan. 27, 1891. The attention of bidders is invited to Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. Further information can be obtained at this office. Applications should be indorsed on envelope "Official Business." D. C. HOUSTON, Colonel of Engineers. 52-4t

PROPOSALS FOR DAMS AND DIKES. U. S. Engineer Office, Cincinnati, Dec. 13, 1890. Sealed proposals, in duplicate, for furnishing material and constructing dams and dikes in the Ohio River, to wit: A crib superstructure on dike at foot of Marietta Island, a dam at head of Blennerhassett's Island, a dike at Cullums, a dike at lower bar at Rising Sun, a crib superstructure on dike at Madison, and a dike at Flint Island, will be received at this office until 12 M. on Thursday, the 22d day of January, 1891, and then opened. All information furnished on application. The attention of bidders is invited to the Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887. WM. E. MERRILL, Lieut.-Col. of Engineers. 52-3t.

DREDGING AT OGDENSBURG HARbor, New York. U. S. Engineer office, Burlington, Vt., Dec. 22, 1890. Sealed proposals, in duplicate, addressed to the undersigned for 270,000 cu. yds., more or less, of dredging; 200,000 yds. from the city front channel, and 70,000 yds. from the channels near the C. V. R. R. Elevators, Ogdensburg Harbor, will be received at this office until 11:30 o'clock A. M., Jan. 22, 1891.

Attention is invited to the Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, p. 332, and Vol. 24, p. 414, Statutes at Large. Detailed information can be had on application. M. B. ADAMS, Major of Engineers. 52-2t 3-1t

UNITED STATES ENGINEER OFFICE, 34 West Congress street, Detroit, Mich., Dec. 27, 1890. Sealed proposals, in triplicate, for furnishing all materials, plant, and labor, and excavating Hay Lake Channel, St. Mary's River, Mich., will be received at this office until 2 o'clock P. M., Jan. 23, 1891, and then publicly opened. Preference will be given to plant and materials of domestic production or manufacture, conditions of quality and price (import duties included) being equal. Attention is invited to Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 24, page 332, and Vol. 24, page 414, Statutes at Large. The government reserves the right to reject any or all proposals, and to waive any informalities in the bids received. For further information apply at this office, or at the United States Engineer Office, Sault Ste. Marie, Mich. O. M. POE, Colonel Corps of Engineers, Bvt. Brigadier-General, U. S. A. 52-3t, 4-1t

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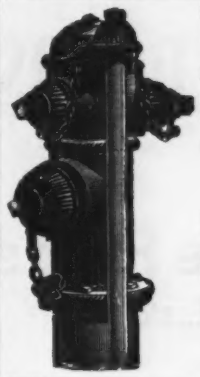

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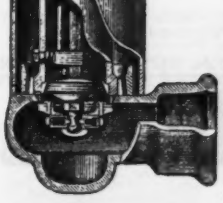

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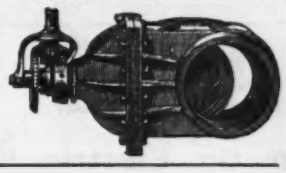

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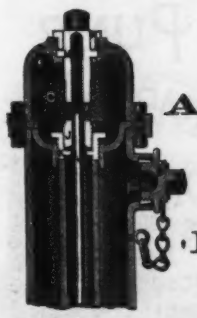

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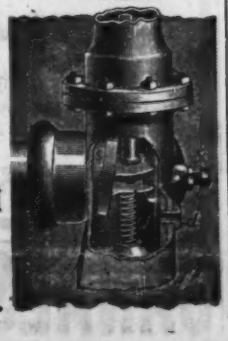

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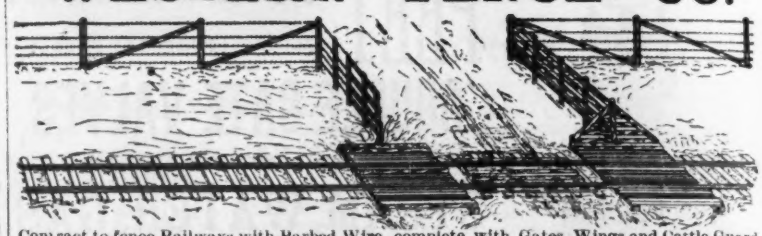

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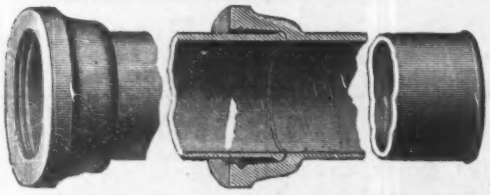

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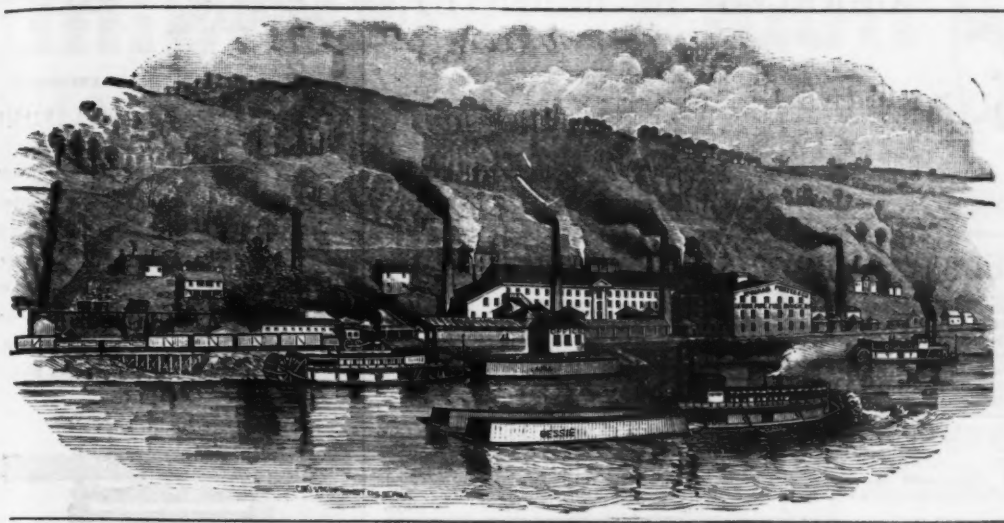

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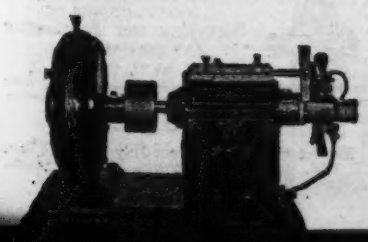

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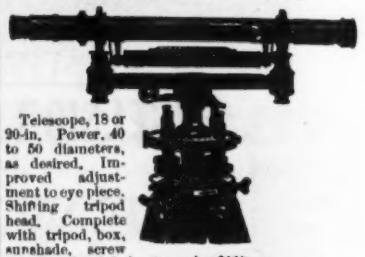

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UNITED STATES ENGINEER OFFICE, 34 West Congress street, Detroit, Mich., Nov. 28, 1890. Sealed proposals, in triplicate, for furnishing all materials and labor and building the masonry of a lock at St. Mary's Falls Canal, Michigan, will be received at this office until 2 o'clock P. M., Jan. 27, 1891, and then publicly opened. Preference will be given to materials of domestic production or manufacture, conditions of quality and price (import duties included), being equal. Attention is invited to Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, vol 23, page 332, and vol. 24, page 414, Statutes at Large. The Government reserves the right to reject any or all proposals; also to award the contract upon other considerations than the price. For further information apply at this office, or to the U. S. Engineer Office, Sault Ste. Marie, Mich. O. M. POE, Colonel, Corps of Engineers, Bvt. Brig.-Gen. U. S. A. 48-6t.

PROPOSALS FOR REPLACING THE present wooden upper or railway deck of the Rock Island Bridge with iron, and for replacing parts of the east and west shore spans of said bridge by stronger members of wrought iron.—Rock Island Arsenal, Rock Island, Ill., Dec. 5, 1890. Sealed proposals, in triplicate, will be received until 2 o'clock P. M., on Wednesday, Jan. 7, 1891, for replacing the present wooden upper or railway deck of the Rock Island Bridge with iron, and also for replacing parts of the east and west shore spans by stronger members of wrought iron, and the building of a new iron deck. Full plans and specifications showing details of construction will be sent to all established builders of iron bridges upon application. Separate bids for the bridge and shore spans must be submitted. The United States reserves the right to reject any or all bids or parts thereof. Blank forms on which proposals must be made and all information required by bidders can be had upon application to Col. J. M. WHITTEMORE, Ordnance Department, U. S. Army, Commanding. 51-3t

ENLARGING JETTIES AT PORT JEFferson Inlet, N. Y.—Engineer Office, U. S. Army, Room H 7, Army Building, 39 Whitehall street, New York, N. Y., December 16th, 1890. Sealed proposals in triplicate, for enlarging jetties at Port Jefferson Inlet, N. Y., will be received at this office until twelve (12) o'clock, noon, on Thursday, January 15th, 1891. The attention of bidders is invited to the Acts of Congress, approved February 26th, 1885, and February 23d, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. Further information, specifications and forms of proposals can be obtained at this office. Applications should be indorsed on the envelope "Official Business. D. C. HOUSTON, Colonel of Engineers. 51-1t

CONSTRUCTION OF BREAKWATER AT BRIDGEPORT, CONN. Engineer Office, U. S. Army, Room H 7, Army Building, 39 Whitehall street, New York, N. Y., Dec. 16, 1890. Sealed proposals, in triplicate, for construction of a Breakwater at Bridgeport, Conn., will be received at this office until twelve (12) o'clock noon, on Thursday, Jan. 15, 1891. The attention of bidders is invited to Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol 24, page 414, Statutes at Large. Further information can be obtained at this office. Applications should be indorsed on envelope "Official Business." D. C. HOUSTON, Colonel of Engineers. 51-4t

U. S. ENGINEER OFFICE, WILMINGton, Del., Dec. 13, 1890. Sealed proposals, in triplicate, will be received at this office until 12 o'clock, noon, on Jan. 12, 1891, and then opened, for dredging in the following named localities, viz: Wilmington Harbor, Del.; Appoquinimink River, Del., and Smyrna River, Del. The attention of bidders is invited to the Acts of Congress approved Feb. 26, 1885, and Feb 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. For all information apply to WM. F. SMITH, United States Agent. 51-4t

PROPOSALS FOR CONSTRUCTION OF breakwater and beacon at Little Harbor, N. H. United States Engineer Office, Portland, Me., Dec. 1, 1890. Sealed proposals, in triplicate, for construction of breakwater at Little Harbor, N. H., will be received at this office, 537 Congress street, until 3 P. M. of Tuesday, Dec. 30, 1890, and then opened. Attention is invited to Acts of Congress, approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. All necessary information furnished by JARED A. SMITH, Lieut.-Col. Corps of Engineers, U. S. Army. 49-2t, 52-1t

PROPOSALS FOR DREDGING IN NARraguagus River, Belfast Harbor, Camden Harbor, and for dredging and removing ledge in Rockport Harbor, Maine. United States Engineer Office, Portland, Me., Dec. 1, 1890. Sealed proposals, in triplicate, for dredging in Narraguagus River, Belfast Harbor, Camden Harbor, and for dredging and removing ledge in Rockport Harbor, Maine, will be received at this office, No. 537 Congress street, until 3 P. M. of Tuesday, Dec. 30, 1890, and then opened. Attention is invited to Acts of Congress, approved Feb. 26, 1885, and Feb. 23, 1887, Vol 23, page 332, and Vol. 24, page 414, Statutes at Large. All necessary information furnished by JARED A. SMITH, Lieut.-Col. Corps of Engineers, U. S. Army. 49-2t, 52-1t

PROPOSALS FOR DREDGING IN COcheco River, New Hampshire. United States Engineer Office, Portland, Me., Dec. 8, 1890. Sealed proposals in triplicate for dredging in Cocheco River, New Hampshire, will be received at this office, 537 Congress street, until 3 P. M. of Tuesday, Dec. 30, 1890, and then opened. Attention is invited to acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, vol. 23, page 332, and vol. 24, page 414, Statutes at Large. All necessary information furnished by JARED A. SMITH, Lieut.-Col. Corps of Engineers, U. S. Army. 50-3t.

U. S. ENGINEER OFFICE, ARMY BUILDing, New York, Dec. 5, 1890.—Sealed Proposals, in triplicate, will be received at this office until 12 o'clock, noon, Tuesday, Jan. 20, 1891, at which place and time they will be publicly opened in the presence of bidders, for the manufacture of the mechanism of a gun lift for a 12-in. high-power gun, and for its satisfactory erection at Sandy Hook, N. J., in accordance with specifications and drawings which may be seen on application at this office. The attention of bidders is invited to the Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. G. L. GILLESPIE, Lieutenant-Colonel of Engineers. 50—4t

IMPROVING VICKSBURG HARBOR, MISS., United States Engineer's Office, Memphis, Tenn., Dec. 11, 1890.—Sealed proposals in triplicate will be received at this office until 12 o'clock noon, on the 11th day of January, 1891, and then opened in the presence of bidders, for dredging in Vicksburg Harbor, Miss. Attention is invited to acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. All necessary information furnished by S. W. ROESSLER, Captain of Engineers. 51-3t

Street Improvement, Washington, Pa.

Sealed bids will be received by the undersigned for the Borough of Washington, Pa., until Monday, Jan. 5, 1891, for the grading and paving of the following streets in said borough:

College	Street,	3,000	feet	in length.
Maiden	do	3,900	do	do
Wheeling	do	3,800	do	do
E. Beau	do	800	do	do
Jefferson	Ave.,	1,300	do	do
N. Main	Street,	500	do	do

The above paving to be done with vitrified fire brick furnished on the ground by said borough.

Also, at the same time, proposals will be received for laying of sewer under the Waring system on the above and other streets, and a main sewer. The approximate amounts of the various sizes of pipes being as follows:

8,000 ft. of 15-in., 1,700 ft. of 12-inch., 1,370 ft. of 10-in., 5,700 ft. of 8-in., 13,000 ft. of 6-in., 10,500 ft. of 4-in., together with necessary Y's, curves, etc., with necessary man holes, inspection pipes and flush tanks.

The said borough will furnish the necessary pipe and castings, holding the contractor responsible for loss and breakage.

Bids will be received for laying the various sizes of pipe per lineal foot, also for the construction of each of the man holes, inspection holes and flush tanks.

Bids will be received only upon blanks furnished by the Secretary.

Each bid must be accompanied by a certified check for $500 as a guarantee that a contract will be executed by bidder if successful.

A bond for faithful performance of contract will be required in one-third the amount of the contract price.

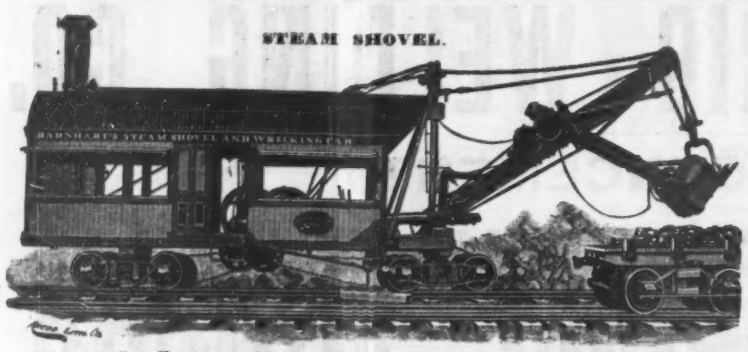
Ten per cent. of the contract price will be withheld until the acceptance of the work, upon completion.

Proposals will be received for the whole work, both for paving and sewering, either for the whole or for a part of the work.

The Borough reserves the right to reject any or all bids. Address communications to

A. M. LINN,
Secretary of Council.
51-3t.

U. S. ENGINEER OFFICE, WILMINGton, Del., Dec. 13, 1890. Sealed proposals, in triplicate, will be received at this office until 12 o'clock, noon, on Jan. 12, 1891, and then opened, for dredging in Manokin River, Md. The attention of bidders is invited to Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. For all information apply to WM. F. SMITH, United States Agent. 51-4t



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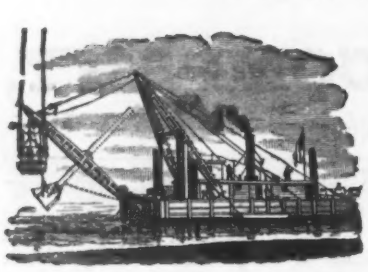

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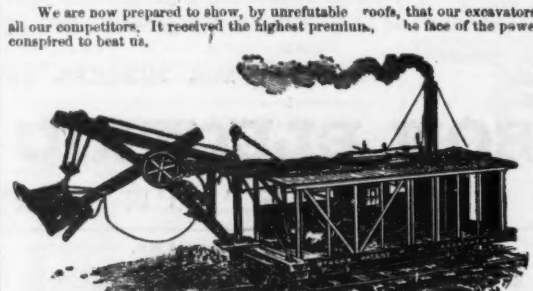

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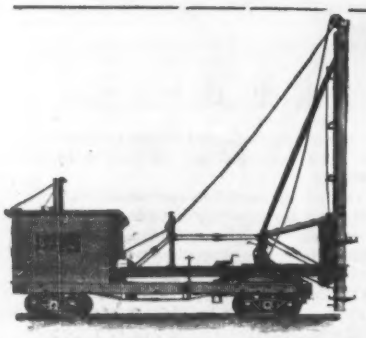

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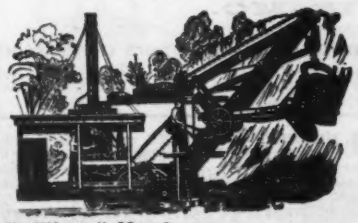

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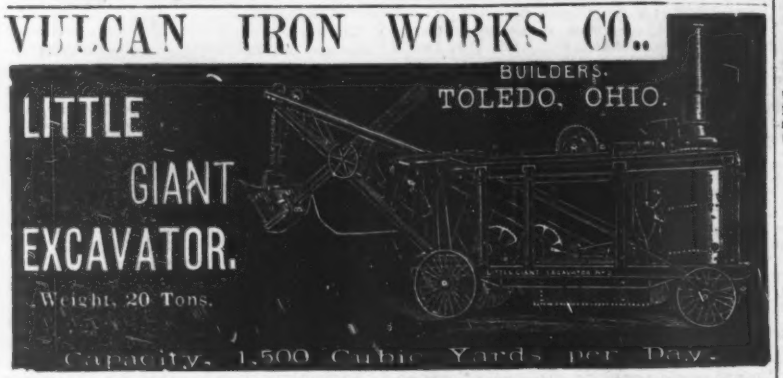

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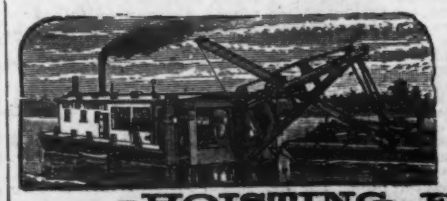

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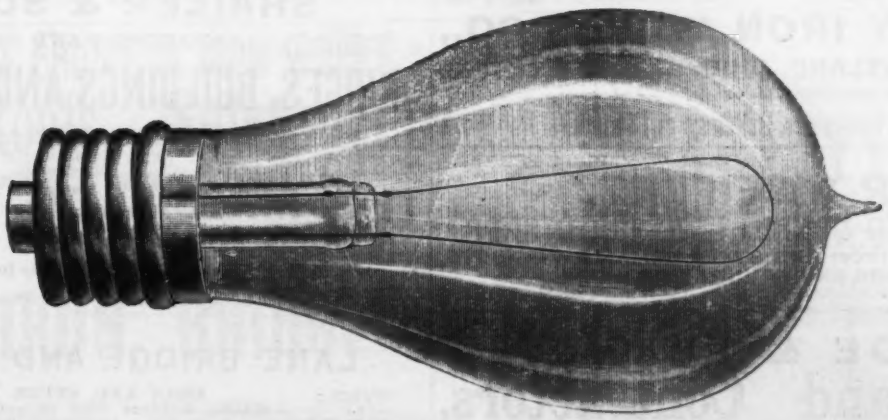

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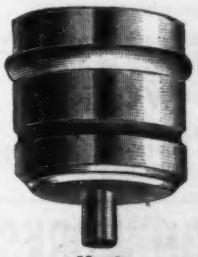

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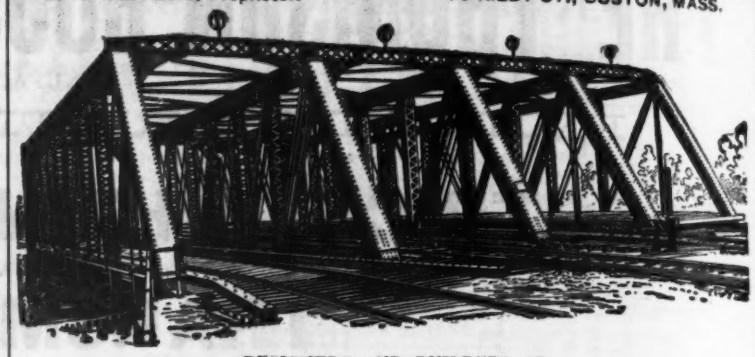

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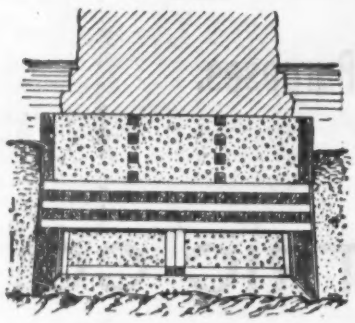

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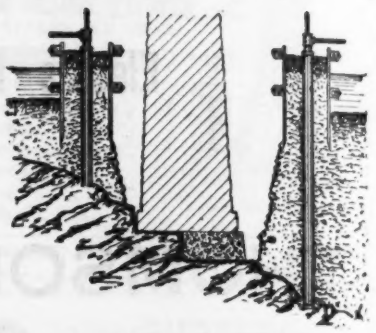

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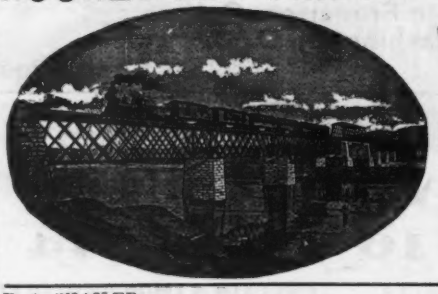

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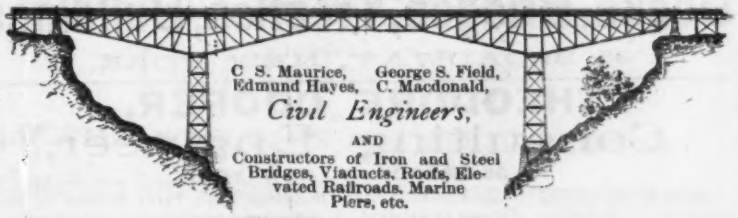

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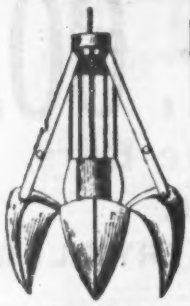

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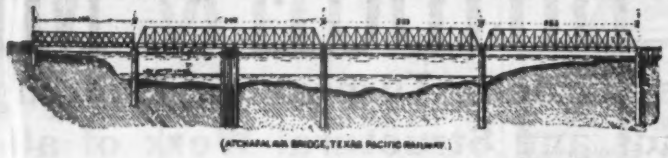

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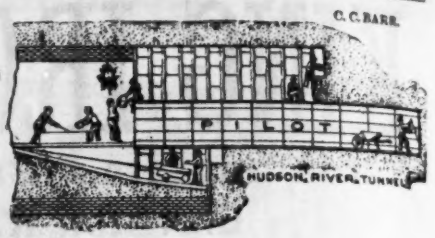

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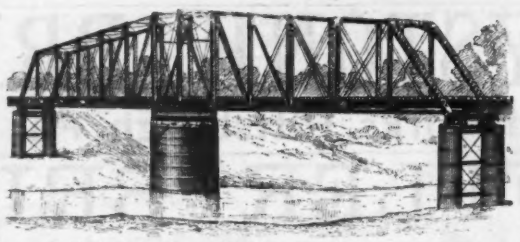

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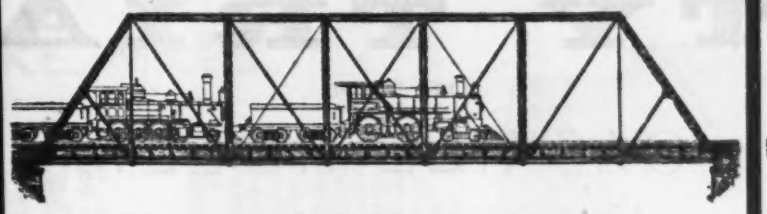

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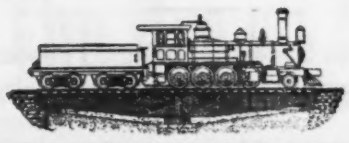

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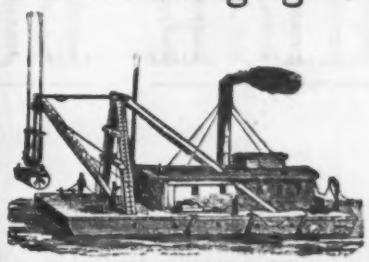

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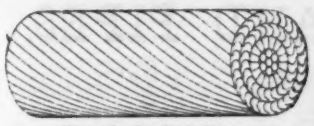

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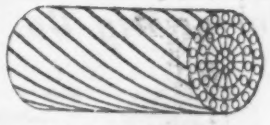

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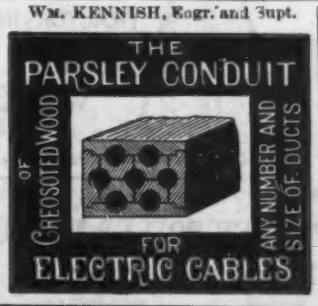

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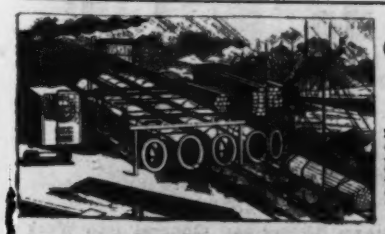

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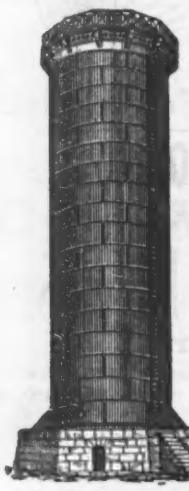

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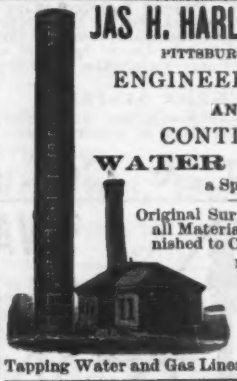

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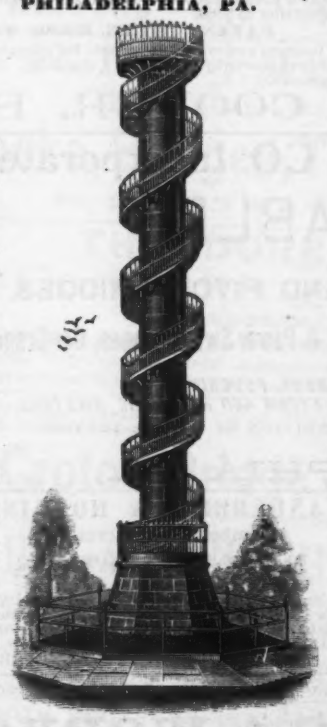

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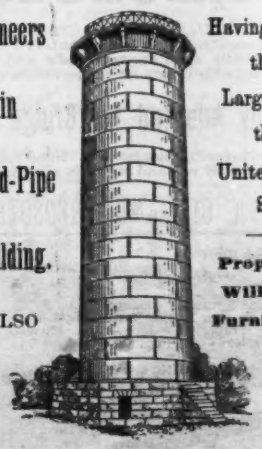

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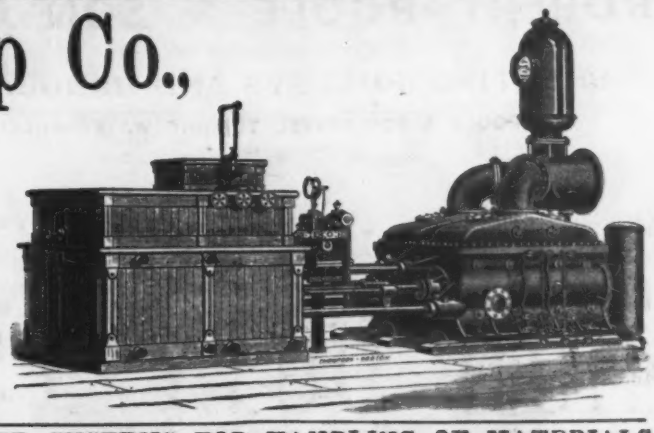

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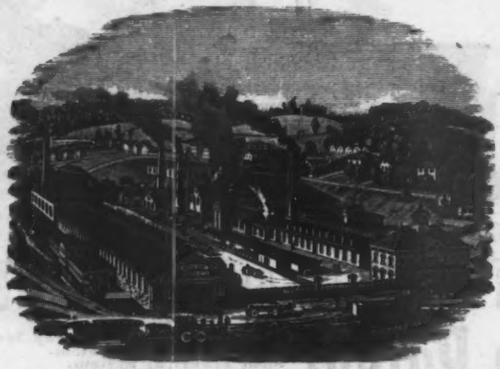

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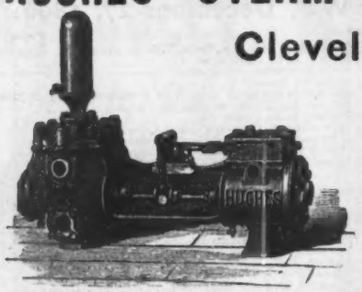

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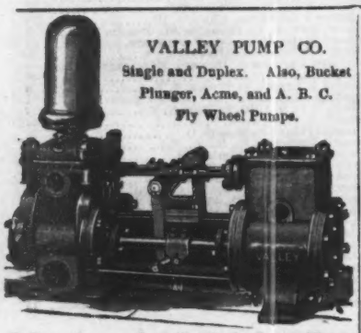

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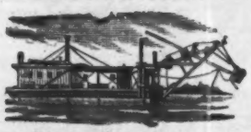

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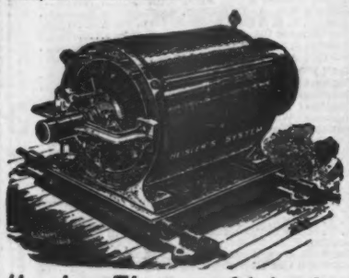

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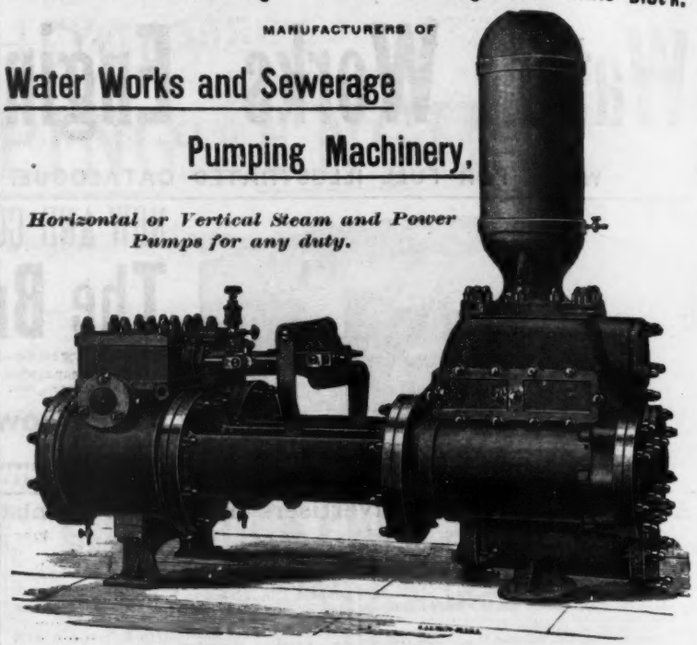

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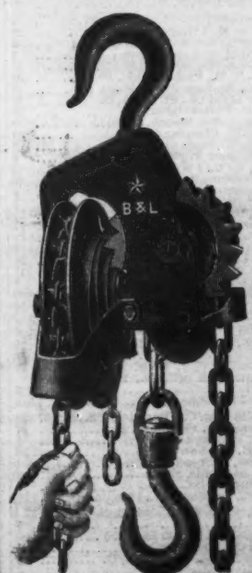

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Year.	No. Per Year	GRAND TOTAL
1881	105	105
1882	1085	1190
1883	4966	6156
1884	15051	21207
1885	10410	31617
1886	8946	40563
1887	9281	49844
1888	27696	77540
1889	24036	101576

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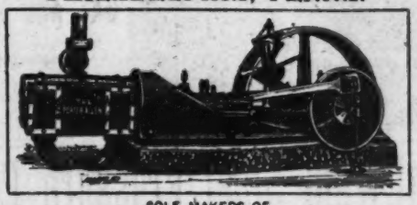

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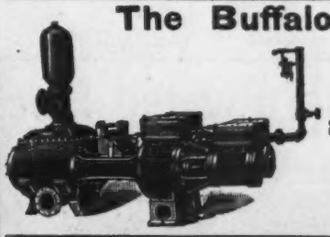

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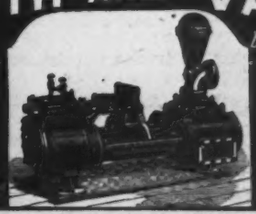

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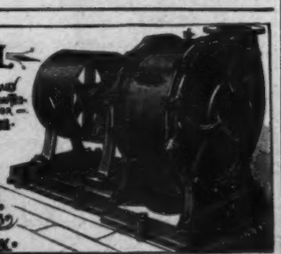

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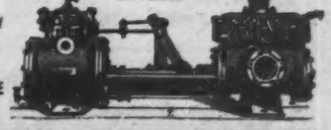

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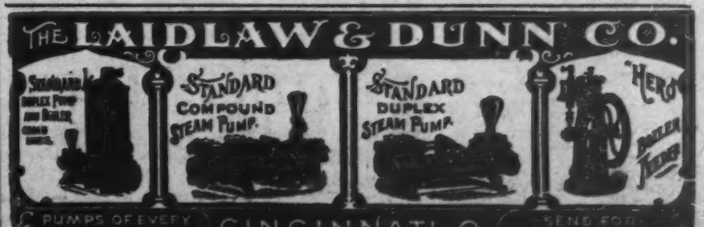

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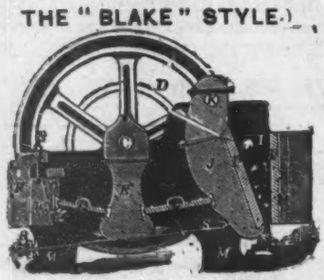

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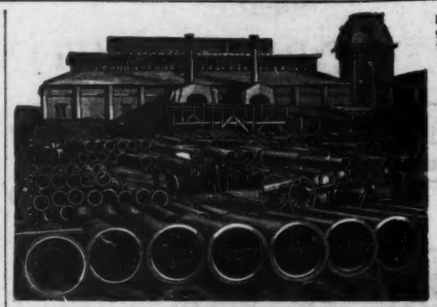

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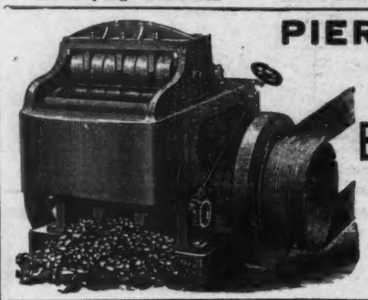

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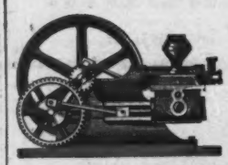

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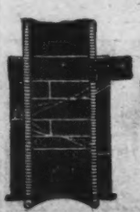

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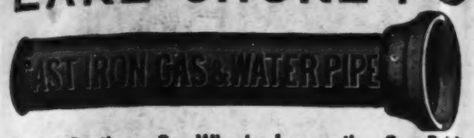

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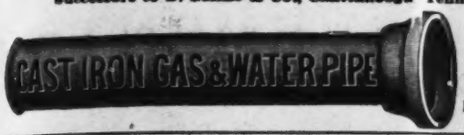

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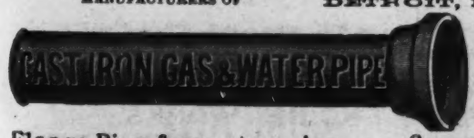

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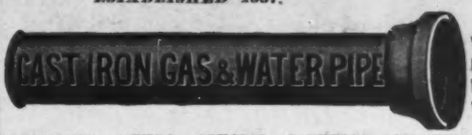

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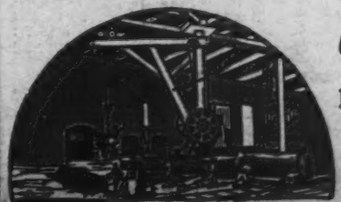

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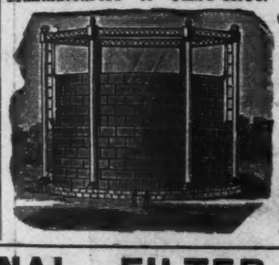
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Tests made under Col. D. C. HOUSTON, Corps of Engineers, U. S. A., of Alsen's Cement used for sea wall around Governor's Island, New York Harbor.
Tensile strength per square inch, 1 day, 394 lbs.; 7 days, 600 lbs.; 30 days, 818 lbs.
Alsen's Portland Cement Works, "Post Bldg., 18 Exchange Place, N.Y

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Stuart's Patent Granolithic and Artificial Stone in any ... a specialty.
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GENTLEMEN—We have used some 3,000 or 4,000 barrels of "Union" Cement, made by the American Improved Cements Company, at Egypt, Pa., and find it superior in Strength to any of the Rosendales, in fact, better than any of the common Cements heretofore used by us.
We have also used a considerable amount of the Standard Portland "Giant" brand made by the same company, with the very best results, and in fact consider it equal, if not superior to most of the foreign Portland Cements. Very respectfully,
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Machines **to let** for digging and back filling. Some simple, some complex. Many sizes. **Utmost economy** in cost of **excavation.** Ten years' use. Used last season in **Boston, Lynn, Haverhill, Nashua, Montreal, Worcester, Albany, Brooklyn, Buffalo, Cleveland, Cincinnati, Chicago, St. Louis, Kansas City,** and many other places.
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F. O. NORTON'S Cement was Used for Pointing.
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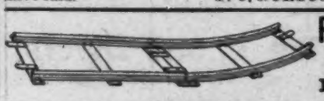
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STANDARD SECTIONS	50	TO	80	LBS.	PER YARD.
LIGHT	16	TO	45	"	" "
STREET RAILS	30	TO	88	"	" "

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THE BARBER ASPHALT PAVING COMPANY.
The extent of pavements laid by this company, prior to Jan. 1, 1890, is as follows:

	Sq. Yds.		Sq. Yds.
Washington	723,730	Chicago	115,961
New York	67,199	Boston	45,226
Buffalo	1,204,678	Kansas City	89,905
Omaha	325,160	Scranton	84,672
Topeka	194,266	Wilkesbarre	67,464
New Orleans	151,147	Harrisburg	42,393
St. Joseph	133,363	Other cities	527,493
St. Louis	86,251		
Louisville	100,069	Total	3,916,574

or equivalent to about 255 miles of 26 ft. roadway.

ITS ADVANTAGES:
Durability, Smoothness, Health, Safety, Noiselessness, Popularity, Cheapness.
It is the only pavement which in this country can to-day show 255 miles of surface in first-class order. It is the standard pavement of America.
It will save 30 to 40 per cent. of the cost of transporting passengers and goods in any city.
It will save 50 to 75 per cent. of repair to vehicles.
It saves human nerves and health, and adds to the comfort of every person who uses a carriage.

This company has laid asphalt pavement in 27 cities of the United States on 618 streets.
It has taken up other pavements and replaced them with Trinidad Asphalt Pavement to the following extent:

Wood	459,033	square yards.
Stone	451,442	" "
French Rock Asphalt	27,134	" "
Coal, Tar and Vulcanite	61,219	" "
Macadam	415,686	" "
Total	1,417,514	square yards.

For plans and estimates apply to the general offices of the Barber Asphalt Paving Company
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Washington, 16 Le Droit Building; New York, 1 Broadway; Philadelphia, 451 North Thirtieth St.; Boston, 12 Pearl St.; Buffalo, Chapin Block; St. Joseph, 513 Francis St.; Topeka, 700 Kansas Ave.; Kansas City, 813 Wyandotte St.; St. Louis, 113 North Eighth St. Louisville, 38 Bull Block; New Orleans, 74 Baronne St.; Chicago, Opera House; Omaha, Ramage Block.